RAPID BLAST V/L ASSESSMENTS USING MACHINE LEARNING – PART 1: NUMERICAL MODELLING AND DATA FILTERING ALGORITHM

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ABSTRACT

High-explosive weapon threats targeting surface ship vessels are designed to penetrate into the ship structure and detonate to inflict the greatest amount of damage to structure, equipment and personnel. Internal blast loading from the detonation of a high explosive charge within a structure provides complex pressure and shock wave dynamics. The ability to capture pressure profiles of these complex blast scenarios is useful for determining loading experienced by structures such as bulkheads, doors and the hull as well as equipment and people within confined spaces. This information is then used to inform damage and failure algorithms within vulnerability/lethality (V/L) modelling assessment tools. This two-part paper series looks at a methodology for generating rapid blast loading parameters to be used in whole platform V/L modelling.

This paper (Part 1) specifically presents the process of generating high-fidelity modelling data and the development of a data filtering algorithm to extract peak pressures, total impulse and quasi-static pressure from an internal blast explosion. The numerical code CTH was used to run internal blast simulations using TNT equivalent explosive within compartments representative of naval ship compartments (1.5 m – 7.5 m dimension range). The data filtering algorithm employs a statistical approach combined with standard peak finding algorithms. Pressure histograms are fitted to a statistical distribution from which a minimum peak pressure is obtained. From the peak pressures and time of the peaks, an impulse cut-off time can be inferred and utilised to return estimates for the quasi-static pressure. A script was developed in Python to obtain the key features of interest for generating a pressure profile database and demonstrate the effectiveness of the data filtering algorithm. In Part 2, the filtered data is utilised along with the Friedlander–Heaviside series to generate a machine learning model capable of providing rapid V/L assessments for compartments subjected to internal blast loadings.