

## **ARTIFICIAL INTELLIGENCE AND SIMULATION FOR ENHANCED PILOT TRAINING**

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### **ABSTRACT**

This paper discusses the integration of Virtual Constructive (VC) simulation and Convolutional Neural Networks (CNNs) into an Agent-Based Model (ABM) to study pilot performance. By leveraging the strengths of VC for immersive training scenarios and CNN for advanced image recognition and decision-making processes, the research aims to provide a comprehensive understanding of how AI and machine learning can help pilot training programs. The paper's series of experiments within the ABM demonstrate the potential of this integrated approach to improve decision accuracy and response times under simulated operational conditions. The findings underscore the effectiveness of integrating VC and CNN into an ABM for training simulations, with implications for pilot training and developing environments that capture operator behavior.

### **1 INTRODUCTION**

The aerospace sector faces pressing demands to adapt and innovate in an evolving global landscape. As new technologies redefine aircraft capabilities and operational landscapes, pilots must adapt their skills and strategies, enforcing the importance of advanced pilot training. Simulations can play a pivotal role by offering pilots a platform to learn and perfect their skills to navigate these scenarios safely. Life simulations and games constitute a subset of simulation in which players control virtual characters (Adams and Rollings 2006). These concepts have been proven instrumental in training, particularly in strengthening weapons combat effectiveness (Kirby et al., 2011). Nonetheless, their standalone deployment poses challenges from resource constraints, reproducibility issues, and associated costs (Kirby et al. 2011, West et al. 2013). Moreover, live simulations may impede training retention from simulated environments to real-world applications (Summers 2012). Virtual simulations provide solutions but also come with limitations. One approach to address these limitations is achieving a 'Live/Synthetic Balance,' which combines live training with synthetic environments to optimize training outcomes and effectively capture operator behavior (Kirby et al., 2011). Leveraging performance data extracted from live and synthetic environments can provide comprehensive insights (Tannenbaum et al., 1993). Evaluating the performance data and implementing machine learning models create the potential for human strategy refinement (Muller 2002).

Multiple papers have explored standalone Live Virtual Constructive (LVC) systems and combat effectiveness analysis, employing diverse methodologies, including discrete event simulation (Armo 2000) and agent-based models (ABMs) (Connors 2015). In Armo (2000), discrete event simulation (DES) was utilized to analyze the effectiveness of a light antisubmarine warfare torpedo against a submarine with a countermeasure system. The ABM framework in Connors (2015) modeled pilot behavior and was employed to analyze weapon effectiveness, focusing on weapons' range, speed, and accuracy. Other simulation models were used to model the combat effectiveness of other military vehicles in complex scenarios, such as attack helicopters (Jung and Lee 2010) and Unmanned Ground Vehicles (Lee et al. 2015). Additionally, data-driven approaches have been instrumental in extracting valuable insights from logs concerning reaction time, strategy, and design limitations. These methodologies, which often integrate machine learning techniques (Oztekin et al., 2013), offer a nuanced understanding of system usability and























