Knowledge-based reasoning in the Paladin Tactical Decision Generation System

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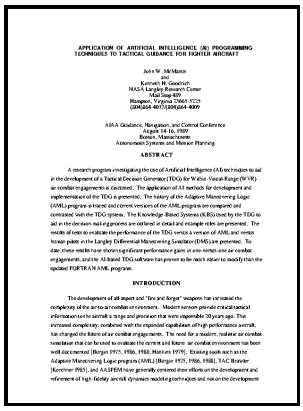
APPLICATION OF ARTIFICIAL INTELLIGENCE (AI) PROGRAMMING TECHNIQUES TO TACTICAL GUIDANCE FOR FIGHTER AIRCRAFT

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AIAA Guidance, Navigation, and Control Conference
August 14-16, 1989
Boston, Massachusetts
Astrodynamics Systems and Mission Planning

ABSTRACT

A research program investigating the use of Artificial Intelligence (AI) techniques to aid in the development of a Tactical Decision Generator (TDG) for Within Visual Range (WVR) air combat engagements is discussed. The application of AI methods for development and implementation of the TDG is presented. The history of the Adaptive Maneuvering Logic (AML) program, a rule-based and current version of the AML program are compared and contrasted with the TDG system. The Knowledge Based Systems (KBS) used by the TDG to aid in the decision making process are outlined in detail and example rules are presented. The results of tests to evaluate the performance of the TDG versus a version of AML and versus human pilots in the Langley Differential Maneuvering Simulator (DMS) are presented. To date, these results have shown significant performance gains in one-versus-one air combat engagements, and the AI-based TDG software has proven to be much easier to modify than the equivalent FORTRAN AML program.

INTRODUCTION

The development of all-aspect and "fire and forget" weapons has increased the complexity of the air-to-air combat environment. Modern sensors provide critical tactical information to the aircraft at ranges and precision that were impossible 20 years ago. This increased complexity, combined with the expanded capabilities of high performance aircraft, has changed the future of air combat engagements. The need for a modern, realistic air combat simulation that can be used to evaluate the current and future air combat environment has been well documented [Burgin 1975, 1986, 1988; Hutchins 1979]. Existing tools such as the Adaptive Maneuvering Logic program (AML) [Burgin 1975, 1986, 1988], TAC Brawler [Kaminar 1985], and AASPEM have generally centered their efforts on the development and refinement of high-fidelity aircraft dynamics modeling techniques and not on the development

Description: -
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Tactics
Knowledge bases
Air combat maneuveringKnowledge-based reasoning in the Paladin Tactical Decision Generation System
-Knowledge-based reasoning in the Paladin Tactical Decision Generation System
Notes: Includes bibliographical references: p. 7.
This edition was published in 1993

Filesize: 54.19 MB

Tags: #CiteSeerX

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Abstract Paladin is a tactical decision generation system for air combat engagements. This allows Paladin to adapt its tactics to the current situation and improves system performance.

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Paladin utilizes a set of air combat rules, an active throttle controller, and a situation assessment module that have been implemented as a set of highly specialized knowledge— based systems. The results of simulation testing showing the error introduced into the situation assessment module due to estimation errors in positional and geometric data for the opponent aircraft are presented.

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The situation assessment module was developed to determine the tactical mode of operation aggressive, defensive, neutral, evasive, or disengagement used by Paladin at each decision point in the air combat engagement.

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Paladin uses highly specialized knowledge—based systems and other Artificial Intelligence AI programming techniques to addresses the modern air combat environment and agile aircraft in a clear and concise manner. The system was developed using the Lisp programming language on a specialized AI workstation. .

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Paladin uses the situation assessment module and the situationally dependent modes of operation to more accurately represent the complex decision-making process of human pilots. Paladin is designed to provide insight into both the tactical benefits and the costs of enhanced agility. .

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