USING AN ASSOCIATE SYSTEM FOR CONTROLLING MULTIPLE UAVS FROM THE CO-PILOT/GUNNER SEAT OF AN APACHE LONGBOW

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ABSTRACT

Starting from the intent modeling work that Applied Systems Intelligence (ASI) did on the Army's Rotorcraft Pilot's Associate (RPA) program in the early 1990s, an on-board associate is being built to provide the Apache Co-pilot/Gunner (CPG) control of multiple UAVs. Based solely on the current world state known to the associate and actions within the cockpit, the associate will attempt to infer what plan the CPG is trying to achieve and adjust a course of action to support that plan. The associate will continue monitoring CPG actions to better explain his intent, as decomposition planning of UAV goal objectives continues. Intent inferencing coupled with dynamic, multi-threaded planning will increase the Apache's range and capabilities by adding control of multiple UAVs without adding tasks for the CPG.

1. INTRODUCTION

To enhance the capability of the Army's Apache Longbow Attack Helicopter, recent work has been done to introduce Unmanned Air Vehicles (UAVs) into the mission operations. Under the Army's Aviation Applied Technology Directorate (AATD) in Fort Eustis, VA, the Airborne Manned-Unmanned System Technology (AMUST) program has initiated researching the challenges of teaming UAVs and manned helicopters. The AMUST program is studying the benefits and challenges of controlling a single Hunter UAV from the Co-pilot/Gunner (CPG) seat in a Longbow. This poster focuses on how to extend the current paradigm to multiple UAVs.

Introducing associate system technologies into the cockpit of the Apache can provide the power to successfully control multiple UAVs during a mission. ASI's associate systems are an architecture built on a knowledge base that includes procedural information, operational data, and a current picture of the world state. Associates are designed to provide planning for predefined behaviors and intent understanding of known actions within a system. By integrating an associate into the CPG's cockpit, any actions the CPG initiates are monitored by the associate and can trigger UAV planning to support the co-pilot's intent. This can be done without dramatically increasing operator workload.

2. DEVELOPING THE APACHE CPG ASSOCIATE

The objective for this work was to design a system for the Apache Longbow that provides teaming capabilities for the Apache and multiple UAVs in the mission environment. The system should provide similar functionality to the RPA Cognitive Decision Aiding System (CDAS) that modeled the pilot's intent and increased his situational awareness. The system also incorporates ASI's experience in developing the decision-aiding software for the Unmanned Combat Air Vehicle (UCAV) program. ASI has built a unique command and control system for unmanned air and ground vehicles using associate technology called C2IT- Command, Control, and Information, Technology. Merging the C2IT knowledge for unmanned vehicles together with the information management experience from RPA, the Apache CPG Associate represents a total integration opportunity for associate technology.

An advantage of an associate system is that it can control multiple types of UAVs during a single mission. UAVs can provide video surveillance and reconnaissance, target laser designation, battle damage indication, communications relays, and even alternative weapons platforms- all under the watch of the CPG in the Apache that is safely under cover. Teaming UAVs with manned vehicles has the potential to greatly increase the mission effectiveness and the survivability of the manned assets. UAVs can act as an extended sensor network for the manned vehicles, allowing them to extend their influence over a much larger battlespace. Whether the Apache is executing an attack sequence or conducting a reconnaissance mission, the associate will have the knowledge necessary to construct an appropriate plan for Apache support with UAVs.

The scenario outlined for the initial design is a scout/attack mission with several pre-planned surveillance targets for unmanned tactical UAVs (Hunters) and several reactive targets to engage by laser designation from a UAV and attacking with the manned Apache. Components of the scenario are:

- 1 Apache AH64-D Longbow in a Multi-role Mission configuration with 4 Aim-9 (air-to-air missiles), 16 Hellfire (anti-tank missiles), 38

FFAR (folding-fin aerial rocket), 1200 30mm rounds (cannon).
- 3 Hunter UAVs with sensors (TV and IR); 1 Hunter carries a laser designator/ rangefinder.
- 1 GCS (ground control station)

In addition to replicating the baseline scenario from the AMUST program, this scenario is intended to capture the Apache CPG reacting to a tank seen in the video from one of the Hunter UAVs. The associate on-board the Apache is monitoring the CPG's actions and interprets his intent to attack the T-72 from actioning the missiles on the Left-Hand Grip. At that point, the associate begins planning to provide a Hunter for laser designation of the target in order to allow the Apache to remain covered as long as possible. The decision aiding system uses the current world state to select a Hunter with a laser designator, that is close to the new target, and is not currently tasked. The scenario continues by demonstrating another Hunter on an associate-provided route maintaining laser targeting while the other UAVs continue on their current plans. The CPG is not required to hand-over the UAVs to a ground control station during engagement; instead the associate will monitor current UAV and threat activities, ensuring the safety of the team.

2.1 Intent Interpretation Process

One of the key technologies provided by associate systems that are essential for successfully controlling multiple UAVs from an attack helicopter, is the ability to perform intent interpretation. ASI's Shared Model of Intent (SMI) module of the decision-aiding system is designed to explain expected actions and work with the operator to explain unexpected actions. SMI uses the same plan-and-goal pattern graph as the Dynamic Planner, but instead of traversing from goals down to actions, the interpreter uses CPG actions to reconstruct planning patterns explaining plans and satisfying goals.

The value of intent interpretation is visible throughout the associate activity cycle. Common representation and understanding of intentions of the CPG become more efficient and extend into the software architecture reducing processing and improving relevant results. A representation of current intentions also provides for an understanding of the information needs of the CPG to maintain his situational awareness. Finally, the intent interpreter's analysis of "unexplained" actions is used to evaluate the consequences and criticality of the unexplained action, and determine the appropriate action of the system. The associate can ignore an action without significant consequence, notify the CPG, intervene in an action, or effect an immediate response if appropriate and authorized.

2.2 Associate Functionality

The Apache CPG Associate is responsible for interpreting the CPG's intent, providing situation assessment, and UAV planning. The scope of the current designed associate is limited to understanding target acquisition and engagement actions for interpretation. Target acquisition procedures using multiple sources and target engagement procedures with different weapons are designed in the knowledge structures used by ASI's core software engine. The knowledge is designed to capture the current world state of the Apache configuration and status, UAV configurations and status, the current threat picture, and CPG tasking. The associate will respond to CPG actions by explaining activity within the cockpit that is intended for target acquisition or engagement. Once the higher level plans of acquisition or engagement are active, the associate will continue monitoring the progress of those plans while also initiating UAV support planning to accomplish the CPG's objective. The associate will propose a plan to the CPG for retasking one or multiple UAVs that are available for assisting in the acquisition or engagement process that the CPG has initiated.

3.0 CONCLUSION

Expanding the AMUST program from a single UAV to multiple UAVs would increase the lethality of the Apache Longbow, the survivability of the Apache, and the versatility of the already advanced attack helicopter. ASI's efforts plan to show that our associate system technology addresses several key objectives for successfully integrating an associate into an Apache cockpit. Those objectives include:

- Supporting crew intent by exploiting ASI's Shared Model of Intent (SMI) component (a derivative of the OPAL module embedded in RPA).
- Supporting planned operations or dynamic re-planning in response to changes during the mission as assessed by the operator or the Associate.
- Supporting single operator - multiple vehicle operations.

These findings can be used to support future Army combat operations, as one operator can be better equipped to support multiple vehicles in a changing tactical environment.