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System Characteristics and Contextual Constraints for Future Fighter Decision Support

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ABSTRACT

Research on decision support systems for fighter aircraft has to regard future manned and unmanned cooperating aircraft. This paper highlights system characteristics and contextual constraints to guide research as well as system development. Long term trends have been identified for the domain that has to be coped with, including the transformation of the fighter pilot from pilot to tactical decision maker. Automation strategies have to be developed to support manned and unmanned aircraft in a joint cognitive system. For instance, for intelligent fighter pilot support, for distributed unmanned and manned decision making, function allocation has to be concerned. For function allocation it is important not only to regard which agent is best at performing a task but also to regard the risk/cost of performing a task in this kind of potentially hazardous context.

KEYWORDS

Decision Support, Fighter Aircraft, Fighter Pilot, Function Allocation, Human Interoperability, Joint Cognitive Systems, RPAV, Scenario, UAV

INTRODUCTION

This paper identifies and describes system characteristics and contextual constraints of an intelligent fighter pilot support system for distributed unmanned and manned decision making. This is central for future manned and unmanned aircraft. The work is based on a literature review of state-of-the-art and domain specific lessons learned from context relevant systems design.

For a manned aircraft the pilot is positioned in the aircraft and in the case of an unmanned aircraft the pilot could be positioned on the ground or in another aircraft. In any case it is important to design for human factors by regarding what is special about this specific context (Alfredson & Andersson, 2013), and to successfully apply cognitive design principles (Alfredson, Holmberg, Andersson, & Wikforss, 2011). For instance, human-centred automation guidelines could be applied to the fighter aircraft domain (Helldin, Falkman, Alfredson, & Holmberg, 2011). Also, design principles for adaptive automation and aiding have been provided by Steinhauser, Pavlas and Hancock (2009). Already today and more so in future contexts, a fighter pilot has to interact with intelligent applications for heterogeneous systems where transparency is important (Helldin, 2014).

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BACKGROUND

Back in the days of early aviation keeping the aircraft in the air was hard in itself. The aviators were often fully occupied by piloting. After years of progress within the domain, the aircraft could be better controlled and there were also time and mental resources to attend to other activities. The pilots found time not only to aviate but also to navigate, and later also to communicate. For instance, military pilots could communicate what they had observed on the ground when landed, providing valuable reconnaissance information. Even later, the history of military aviation is full of different types of aircraft carrying out very different missions in a variety of scenarios. Today´s fighter pilots make use of an “autopilot” or other functions to aid the piloting of the aircraft. Moreover, modern fighters are equipped with high tech sensors, advanced weapon systems, electronic warfare systems, and many other subsystems for a modern fighter pilot to handle. If you were ever given the opportunity to look at the instrumentation of a modern fighter aircraft performing a tactical mission, you would probably see that instrumentation and displays to a great deal is used for tactical considerations and not only for flight instrumentation. The role of a fighter pilot has been transformed over time; from pilot to tactical decision maker.

This long term trend has led to current situations where a fighter pilot has to manage several tactical subsystems simultaneously. At the same time, he has to assess ongoing parallel tactical situations on the ground and in the air, and make fast and important decisions to provide influence on the situations. Naturalistic decision making, as it were characterised by Klein, Orasanu, Calderwood, and Zsambok (1993), is applicable to many of these situations, since they are often complex, uncertain and dynamic, characterised by high stakes, potentially risking both own and others life under extreme time pressure. Moreover, demanding situations may appear suddenly, when performing almost any military mission, either it is an air-to-air mission, an air-to-surface mission or a reconnaissance mission.

Today, and perhaps even more so in future aircraft systems, the future pilot has to regard and interact with even more and more information. This trend increases the need to support decision making. At the same time, there is a trend towards increasing abilities to support decision making. For instance, the computational power of modern avionics has increased substantially, and the human-machine interaction technology has been improved, providing fighter aircraft development engineers with new means of supporting fighter pilot interaction during difficult situations. There has been a long term trend towards increasing communication abilities between pilots, not only including oral communication but also various means of data communication, allowing new means of communication between pilots as well as with command and control functions and more. Moreover, the cognitive ability for technical agents the fighter pilot is in contact with, either direct by own manipulation and control, or indirect through another human, is increasing. Examples of technical agents that could influence the situation for a fighter pilot is a decision support system in the own aircraft as well as equivalent systems on other platforms, autonomous or highly automated unmanned aircraft or command and control decision support systems, as well as intelligent support systems for planning and evaluating the own mission. Also, some technical agents possess ability to support each other with data, including situation assessments, status of own system capabilities etcetera.

The further this trend is going the greater the abilities become to distribute decision making. One cognitive agent, human or technical, could very well pre-process information that another agent is making a decision based on, that yet another agent is executing, etcetera. There are also tactical needs to distribute abilities between various cognitive agents. For example, it might be more acceptable to expose unmanned systems to high risk settings simultaneously as a human agent is assigned to judge the situation supported by decision support technology, all being distributed in the total system by location and/or in time. At the same time, as the technology for unmanned systems is matured, a parallel trend is emerging towards even more competent unmanned aircraft, with various capabilities. Hence, new opportunities emerge to generate intelligent fighter pilot support for distributed unmanned and manned decision making.

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