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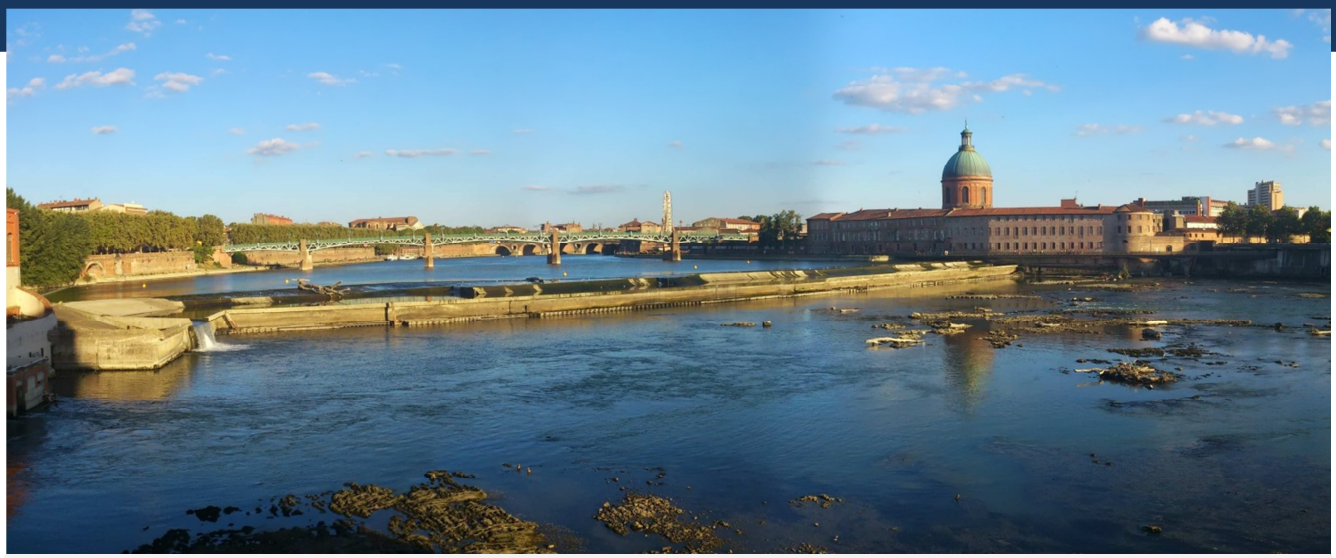

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Design, Implementation and Evaluation of a Manned-Unmanned Teaming Concept for Fighter Jet Missions

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Content

In the proposed presentation, we want to give an overview of our research in the domain of Manned-Unmanned-Teaming (MUM-T) for fighter jets. The Institute of Flight Systems (IFS) aims to develop a concept of MUM-T for airborne military operations by means of work system analysis and cockpit simulation of full missions. From that, we develop solutions to the main challenges of MUM-T.

In future operating environment, mixed teams of manned and unmanned fighter jets might pursue mission goals which formerly were executed by exclusively manned platforms. This requires unmanned aerial vehicles (UAVs) to perform tasks from operations such as Air Interdiction (AI), Suppression of Enemy Air Defence (SEAD) or Offensive Counter Air (OCA). Furthermore, emerging technologies such as swarming enable new operational uses and roles in Combined Air Operations Course (COMAO). However, the implementation of such a operational concept bears major challenges for human factor engineering, system design and cognitive automation.

In our lab, we implemented a research simulator for a manned fighter jet guiding several unmanned platforms. We approached this undertaking in a top-down manner: Firstly, we derived scenarios for future fighter operating environments the analysis of technological trends. Secondly, a suitable human-autonomy-teaming concept was derived for these scenarios by conducting a cognitive work system analysis. Thereby, we identified functional requirements for UAV and cockpit automation as well as the relation between the jet pilot and the UAVs. Finally, we developed a research simulator and evaluated our approach in human-machine-experiments with fighter pilots of the German Luftwaffe as a proof-of-concept.

As the main concept for delegation of UAVs from the cockpit, we present a scalable autonomy concept flexible enough to express the various tasks and tactics of a fighter jet team. The implementation of this concept is enabled by autonomous task execution of UAVs and Swarms as well as a mixed-initiative mission planner to support the pilot in COMAO task delegation and scheduling. To mitigate automation-induced effects such as complexity or opacity, we further developed a pilot assistance system, adapting its behaviour to the mental state of the pilot in the cockpit. Therefore, it estimates the pilot mental state (e.g. activity, mental workload, and situation awareness) and acts accordingly. The developed mission and cockpit simulator fully integrates the described implementations into one operable system.

Apart from the demonstration of a fully operable MUM-T simulator, the key findings were the following: The pilots had very high trust in their unmanned team members and appreciated them as intelligent, capable platforms. The concept of scalable autonomy proved to be a crucial aspect. On the one hand, a high automation level was chosen for time-critical situations while on the other hand low-level control was applied to improve automatically generated solutions. Also, the integration of military operational knowledge into a flexible mission planning and UAV guidance system enabled the pilots to implement tactical considerations into the mission plan.

Conclusively, MUM-T must be considered an integrated system design problem where various aspects must be considered ranging from control algorithms to human factors.

Keywords : Man-machine cooperative techniques