ARTIFICIAL INTELLIGENCE

DM630/Leonardo S.p.a. - AI-based virtual assistant with adjustable autonomy for aeronautic applications

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Context of the research activity	This research project aims to investigate the potential of AI in improving decision-making within high-stakes aeronautical environments. By developing deep learning models that integrate and model procedures across multiple simultaneous tasks, this research aims at augmenting the capabilities of pilots in managing complex, multitask scenarios. The project will first focus on algorithms predicting procedures personalized on various inputs like environmental, user, and task specifications. It will then investigate how different tasks and their associated procedures might be efficiently synergized. Progetto finanziato dal PNRR a valere sul DM 630/2024 - CUP: E14D24002330004
	In aeronautical applications, artificial intelligence holds substantial potential to support human decision-making [1]. Pilots, who often operate under high stress, must manage various concurrent tasks and make swift, accurate decisions to prevent incidents. In this situation, humans are particularly skilled at handling complex tasks by decomposing them into a series of sequential steps, commonly referred to as procedures. The atomic steps composing procedures (i.e. actions) often intersect across different tasks, enabling effective multitasking and the efficient allocation of effort across activities. Additionally, individuals must skilfully adjust to changing demands triggered by task requirements or priorities, evolving environmental conditions, or the needs of users. Deep learning models can be trained to learn these procedures from

Objectives	egocentric or exocentric instructional videos [2,3], aiding in human decision-making. However, existing solutions do not yet support scenarios involving simultaneous activities [4] or adapt the output procedures based on user, environmental, or task requirements, all while ensuring privacy preservation. This PhD project aims to create deep learning models that enhance human decision-making by modeling and integrating procedures across several concurrent activities, utilizing extensive knowledge bases from multi-modal Foundation Models [5,6]. The research focuses on two pivotal aspects: 1) procedural learning with personalizations that adapt the predicted procedure to individual user, task, or environmental specifics; and 2) multi-activity procedural learning, which involves determining how diverse simultaneous procedures can be efficiently synergized. Together, these points aim to establish a framework that augments human decision-making capabilities under varying conditions, paving the way for adjustable autonomy. Ultimately, the algorithms developed will enhance and extend human capabilities in planning multi-task, goal-oriented procedures, with a special focus on the high-stakes field of aeronautics. This work is expected to significantly boost safety and efficiency by assisting pilots in complex decision-making scenarios by capitalizing on the extensive knowledge and predictive power of AI systems. This research is part of an industrial collaboration with Leonardo Spa and it will involve a 6-month internship with the company. It is expected that the scientific results of the project will be reported at top computer vision, robotics and machine learning conferences (IEEE CVPR, IEEE ICCV, ECCV, IEEE IROS, IEEE ICRA, NeurIPS, ICML). At least one journal publication is expected on one of the following international journals: IEEE PAMI, IJCV, CVIU. [1] Zhang, Zelun Tony, et al. "Beyond Recommendations: From Backward to Forward AI Support of Pilots' Decision-Making Process." arXiv preprint: 2406.08959, 2024. [2] Zhou, Honglu, et al. "Procedure-aware pretraining for instructional video understanding." CVPR 2023. [3] Nagasinghe, Kumaranage Ravindu Yasas, et al. "Why Not Use Your Textbook? Knowledge-Enhanced Procedure Planning of Instructional Videos." CVPR 2024. [4] Price, Will, Carl Vondrick, and Dima Damen. "Unweavenet: Unweaving activity stories." CVPR 2022. [5] OpenAI. Gpt-4 technical report, 2023. [6] Chen, Boyuan, et al. "Spatial VLM: Endowing vision-language models with spatial reasoning capabilities." CVPR 2024.

Skills and competencies for the development of the activity	- Strong understanding of linear algebra, calculus, probability, and statistics. - Solid foundation in machine learning, including both supervised and unsupervised learning. - Good programming skills, proficiency in programming languages (Python is required, C++ is a plus). - Familiarity with at least one recent deep learning framework (PyTorch, JAX, or TensorFlow). - The candidate is expected to be proactive and capable of autonomously studying and reading the most recent literature. - Ability to tackle complex problems and algorithmic thinking.

	- Be fluent in English, both written and oral.