COMPUTER AND CONTROL ENGINEERING

MURDM 117/Stellantis -Novel algorithms and synthetic dataset creation for face & body pose recognition in the wild applied in cockpit emergency access

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Context of the research activity	The main goal is to provide an innovative methodology and solution for the vehicle owner's recognition in emergency access conditions that can operate "in the wild", i.e., that can quickly and accurately detect, recognize, and verify the owner's identity in presence of harsh conditions (highly variable lighting, presence of other subjects, impact of possibly constrained vision systems on the image quality, etc.). Attention will be focuses on face and body pose. Synthetic datasets are expected to be exploited in the training of the devised models for data quality, scalability, ease of use and privacy compliance purposes. The activities will be carried out in collaboration with CRF and STELLANTIS. Progetto finanziato nell'ambito del PNRR - MUR DM 117/2023 - CUP E14D23002020004
	Face recognition is one of the key components for future intelligent vehicle applications, such as determining whether a person is authorized to operate the vehicle or not. The challenge is to build a fast and accurate system that can detect, recognize, and verify the driver's identity in presence of constraints introduced in the car environment in different lighting and other external conditions. Furthermore, if the problem of recognizing the owner of a vehicle moves outside the car itself, that is, the system must recognize the owner in emergency access conditions, the problem becomes even more tough. Considering the challenges related to such an "in the wild" recognition, no complete face recognition system tailored to the car environment has been reported yet. The above considerations can be easily extended also to human pose estimation that, together with face verification/recognition, can

Objectives	play a key role in next-generation human-vehicle interaction. Hence, the main goal of this research will be the design and implementation of a novel machine/deep learning algorithms for supporting face and body pose recognition in the mentioned conditions. Based on the described context, the work plan for the research will be organized as follows: - Development of a semi-automatic computer graphics pipeline to simulate different images of the person considered as the vehicle owner; extensive domain randomization will be used to train models robust to variations in terms of, e.g., skin color diversity, aging, facial changes, etc. - Design of a semi-automatic computer graphics pipeline to simulate different types of scenarios in the proximity of the vehicle; domain randomization will be further employed to train models robust to variations in terms of, e.g., illumination, presence of other human and non-human subjects, etc. - Release the created datasets containing the annotated images that allows suitable algorithms to (learn how to) differentiate subtle intra-class variations (including different setups of the same face and person pose model) from deformations occurring due to various reasons. In the 1st year, the candidate will carry out an overall evaluation of the main research goal, will review the state of the art in the field and will define an appropriate application as a study case for emergency access, setting up the functional architecture of the algorithm. Also, a first feasibility evaluation, considering different sensors configuration and infrastructure information will be performed. In the 2nd year, the candidate will focus on deep learning methods for face detection and recognition and human pose estimation, tracking the latest research trends and analyzing the characteristics of the methods devised so far for the considered use case. Synthetic data generation will be also part of the main activity to be carried out. The created datasets will be employed for training. In the 3rd year, the candidate will develop and implement the whole emergency access in the cockpit algorithms, model training, etc. It will be considered the possibility to use the experimental data from a demo car. Finally, the candidate will work on the validation of the proposed solution performance. During the 2nd and 3rd years, the candidate will perform a significant part of the testing at the STELLANTIS premises. The central part of the research will be carried out at the CRF facilities in Turin, and in remote with AEES/SCIC team & facilities (Vélizy – Villacoublay, Paris). The candidate will also be involved in a period abroad in a STELLANTIS group facilities (probably in France). The research activity will aim to disseminate the proposed solutions in the primary publication venues and the automotive industry, encouraging cross-fertilization of research results and new collaborations with other research actors. In particular, publications will target conferences (e.g., CVPR, ECCV, ICPR) and journals in the areas of machine/deep learning, computer vision and vehicular technologies. Target journals include, e.g., IEEE Transactions on Pattern Analysis and Machine Intelligence, International Journal of Computer Vision, IEEE Transactions on Neural Networks and Learning Systems, IEEE Transactions on Visualization and Computer Graphics, Pattern Recognition, Computer Vision and Image Understanding, Journal of Machine Learning Research, IEEE Transactions on Vehicular Technology.

Skills and competencies for the development of	Programming skills in C/C++/Python. Knowledge of machine/deep learning and computer vision techniques and frameworks.

the activity	