LABO - Axe et Equipe *ISPR, ComSee*

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Title of PhD subject: *PRECOG: Precognition for Human-Machine Cooperation*

Summary :

Context and Challenges:
In an environment where cooperation between humans and machines is becoming increasingly important, the safety, efficiency, and acceptability of technologies — especially in areas such as autonomous navigation, industrial robotics, and medical robotics — partly depend on the machines' ability to understand and predict the intentions of the actors present in a scene. However, current anticipation approaches are often limited to primitive actions in controlled environments, while human behaviors, particularly at a higher semantic level, remain difficult to model and predict.

Thesis Objectives:
The thesis project titled "PRECOG Project" aims to develop a neural network architecture based on computer vision that can infer the intentions of agents present in a scene by analyzing various behavioral indicators. The goal is to anticipate future actions to optimize human-machine cooperation and improve the performance of autonomous robotic systems. To achieve this, cognitive neuroscience studies will be leveraged to integrate theoretical models on the formulation of intentions and their link with concrete actions.
The aim is to propose a solution that is application-context agnostic, thereby facilitating its deployment across various sectors (autonomous vehicles, industrial cobotics, etc.). Ultimately, the project seeks to increase the technological readiness level (TRL) of the targeted applications.

Approach and Methodology:
The project's approach is structured around several key areas:
Data Acquisition and Processing: The use of high-performance cameras, complemented by other sensors (LiDAR, odometry, radar, etc.), will enable the collection of a large number of indicators. These will not be limited to classic measurements (pose, kinematics, classification) but will also include less commonly exploited signals such as gaze, emotion, and collective attitude.
- Two-Level Architecture: The first level infers low-level intentions common to all contexts by relying on recurrent networks (LSTM) to capture the spatiotemporal dynamics of the scenes. The second level adapts these predictions to the specific context (domain adaptation), reinforcing the identifiable primitives through studies on interpretability and explainability.
- Creation of Dedicated Databases: To train and validate the models, experimental scenarios will be designed, notably using the PAVIN platform to generate realistic video sequences within the framework of autonomous vehicles.

Collaboration and Strategic Impact:
The project brings together the interdisciplinary expertise of the Institut Pascal and Dalarna University (Sweden). The Institut Pascal contributes its skills in AI, robotics, and experimentation, while Dalarna University offers its knowledge in behavioral neuroscience and rigorous experimental methodologies. This synergy aims to open a new research theme by integrating intention prediction into robotic systems. A previous collaboration between the proponents of this project has already resulted in several joint publications on assistive robotics for people with disabilities [1].
[1] Rybarczyk Y., Ait Aider O., Hoppenot P., Colle E. Remote control of a biometrics robot assistance system for disabled persons. AMSE Modelling, Measurement and Control, 63(4), 47-56, 2002