

# **Resilience in human-machine systems by adjustable autonomy and human-machine cooperation – Perspectives on affordance-based trading of authority**

Zieba Stéphane  
Laboratory for Cognitive Systems Sciences  
Department of Risk Engineering  
University of Tsukuba

## **ABSTRACT :**

In this talk, the notion of resilience in human-machine systems is developed by introducing a mode of human-machine interaction placing the human operator and the robot at the same decisional level. In the human-machine system, resilience is controlled by human-machine cooperation and adjustable autonomy.

Resilience is the property of a system to keep or recover a stable state, and thereby allowing it to continue operations, after a major mishap or in presence of continuous stress. In a first step, criteria are proposed to assess the resilient functioning of the system. Resilient functioning is partly based on adaptation (control by adjustable autonomy) and interactions (control by human-machine cooperation) between the agents. These two means of control will be detailed in this talk.

A definition of autonomy of an agent is thus proposed, which distinguishes semantic aspects (skills, capacities and prescriptions) for three levels of activity (achievement of a task, selection of an alternative, definition of an action plan). The formalism associated with this definition then allows modelling the conditions for applying the forms of human-machine cooperation (augmentative, integrative and debative).

Finally, formalism is developed and exploited in an ongoing work to take into consideration the dynamic nature of the perception of situation. This work is centred on the concept of affordances, that is to say the opportunities of actions offered to an agent by its environment. Incorrectly perceived affordances are modelled with this formalism. Solutions to process these erroneous situations are detailed with the processes of human-machine cooperation and adjustable autonomy.

*Keywords: resilience, human-machine cooperation, adjustable autonomy, affordances.*