

## Experimental Simulation Set-Up for Validating Out-Of-The-Loop Mitigation when Monitoring High Levels of Automation in Air Traffic Control

**Authors :** Oliver Ohneiser, Francesca De Crescenzo, Gianluca Di Flumeri, Jan Kraemer, Bruno Berberian, Sara Bagassi, Nicolina Sciaraffa, Pietro Aricò, Gianluca Borghini, Fabio Babiloni

**Abstract :** An increasing degree of automation in air traffic will also change the role of the air traffic controller (ATCO). ATCOs will fulfill significantly more monitoring tasks compared to today. However, this rather passive role may lead to Out-Of-The-Loop (OOTL) effects comprising vigilance decrement and less situation awareness. The project MINIMA (Mitigating Negative Impacts of Monitoring high levels of Automation) has conceived a system to control and mitigate such OOTL phenomena. In order to demonstrate the MINIMA concept, an experimental simulation set-up has been designed. This set-up consists of two parts: 1) a Task Environment (TE) comprising a Terminal Maneuvering Area (TMA) simulator as well as 2) a Vigilance and Attention Controller (VAC) based on neurophysiological data recording such as electroencephalography (EEG) and eye-tracking devices. The current vigilance level and the attention focus of the controller are measured during the ATCO's active work in front of the human machine interface (HMI). The derived vigilance level and attention trigger adaptive automation functionalities in the TE to avoid OOTL effects. This paper describes the full-scale experimental set-up and the component development work towards it. Hence, it encompasses a pre-test whose results influenced the development of the VAC as well as the functionalities of the final TE and the two VAC's sub-components.

**Keywords :** automation, human factors, air traffic controller, MINIMA, OOTL (Out-Of-The-Loop), EEG (Electroencephalography), HMI (Human Machine Interface)

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