Eye movement analysis to evaluate ghosting and targeting aids for controller assistance

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Abstract

The paper is concerned with eye movement data analysis to investigate the effects of assistance tools in air traffic control on information acquisition behaviour. A late merging concept for arrival management promises significant benefits in terms of noise reduction and fuel efficiency. However, the concept involves changes of controllers' tasks and first studies have shown that the execution of these tasks using only a conventional radar display puts high demands on the air traffic controller. Three assistance variants have been developed as augmentations of the radar display which are (1) manual ghosting, (2) automated ghosting, and (3) targeting. The four-stage model of human automation interaction was used to compare the three assistance variants and the conventional radar display and to work out differences in terms of levels of automation. The identification of subtasks relevant for information acquisition within the four-stage model was used to derive specific hypotheses for the information search processes within each design variant. Eye movement data were recorded during a microworld study using the different ghosting and targeting variants and an unsupported condition. A segmentation of the radar display into static areas of interest was used for eye data analysis, to study the differences in information acquisition over all four conditions. Fixation frequencies and gaze-transitions were used to identify which information was collected, which information was ignored and which gaze-transitions are important for specific controller tasks. The objective eye data confirm the hypotheses that aircraft in the periphery of the radar display receive less attention in the automated ghosting and targeting condition, but not in the manual ghosting condition. It was also shown that the representation of different information in the design variants influences which gaze-transitions become important for the controller task. It is concluded that the applied approach with static areas of interest for eye data analysis is useful to investigate information acquisition strategies using ghosting and targeting functions and to measure attentional distribution across airspace regions. An extension of the approach including dynamic areas of interest for moving objects could bring additional insights. The presented results on information acquisition strategies using ghosting and targeting will be related to other data (e.g. control performance and situation awareness measures) to inform future design decisions regarding controller support for late merging operations.

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