Flight operations using touchscreen controls: assessing system usability and pilots' visual attention

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SUMMARY

Although the integration of multifunction touch screen controls (TSCs) in future flight decks is under development, some safety concerns still exist from pilots' point of view. It is important that usability and human factors considerations are therefore studied in realistic operational environments. This short paper investigates the usability and human-computer interaction associated with TSCs, using eye tracking technology for future flight deck design.

KEYWORDS

Flight Deck Design, Human-Computer Interaction, Visual Behaviours

Introduction

Currently, there are ongoing innovative developments associated with the next generation of flight deck design and multifunction flight deck controls, and these developments increasingly explore the application of touch screens. This paper focuses on multifunction touch screen controls (TSCs) for future flight operations, as it is important that usability and human factors considerations be studied in realistic operational environments. To ensure the integrity and reliability of these complex mechanical systems, the pilot-flying (PF) and the pilot-monitoring (PM) must conduct cross checks by moving their head and eyes to the levers on different positions and landing light buttons on the top of overhead panel. The application of touchscreen technology in this area can reduce pilots' head-down time and to increase situation awareness (SA), which is a significant advantage of using touch screens. However, TSCs in the flight deck may also create some safety concerns during hazardous situations (such as turbulence) which are stressful for pilots (Cockburn et al., 2017). Therefore, implementation of TSCs on the flight deck must demonstrate high usability and safety with regards to human-centred design, so as to satisfy regulators' requirements.

Method

Participants: five participants whose ages from 23 to 58 years old (M=36.2, SD=16.7) with varying levels of flight experience (M=2842, SD=5881) took part in this research. Research Tools included: (1) the Rolls-Royce award winning Future System Simulator (FSS), which provided the ability to quickly model current and future aircraft configurations, as well as design new TSCs to facilitate human-centred design in flight operations (Figures 1 & 2). The FSS can support research into dual pilot, single pilot and even autonomous flight; (2) a light-weight device eye tracker which consists of a headset, including two cameras for visual behaviours and pupil dilation data collection and analysis; (3) system usability of TSCs were measured post-trail with the System Usability Scale (SUS), which has been used on human-computer interaction assessment (Rudi et al., 2020).

Participants wore an eye tracker conducting calibration in the FSS and were acquainted with the TSCs for operating flaps, landing gears, airspeed selector and spoilers (figures 1 & 2) on instrument landing scenario for two different tasks (PF & PM). The participants then provided an SUS rating based on his/her own experience and provided feedback.

Result and Discussion

The results revealed various human factors implications associated with TSCs on the flight deck. The innovative flight deck design must consider pilot's operational environments and characteristics of tasks for both PF and PM, although PM have significant higher rating than PF on the TSCs application, t (4) = 2.29, p =.04, d=.88. In general, the system usability of TSCs is consistent with the proximity compatibility principle (Carswell & Wickens, 1996) and is rated as convenient to use and easy to learn (M=77.5, SD=13.3) compared with the average score of 67.5. Furthermore, PF's visual attention was distributed among the view of the outside runway and cockpit displays, while PM mainly focused on interacting with TSCs on the flight deck during landing. The heatmaps demonstrated visual scan patterns which are different between PF and PM (figures 3 & 4).

Figure 1: Eye tracker shows PF's visual attention while calling for PM deploying spoilers, the fixation on the centreline of runway

Figure 2: Eye tracker demonstrates PM's visual attention while deploying spoilers using TSCs, the fixation focus on the touchscreen

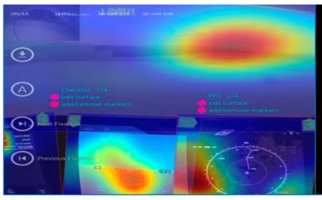

Figure 3: Heatmap shows PF's visual attentions among runway and displays on the flight deck

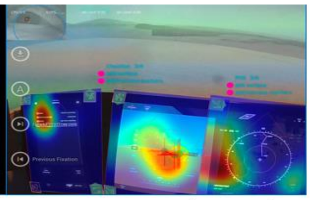

Figure 4: Heatmap shows PM's visual attentions among checklist, PFD and ND on the flight deck

Conclusion

Since PF and PM perform different tasks, their visual attention and operational behaviours when interacting with TSCs were observed to be different. The usability of TSCs has been demonstrated as beneficial and can be easily operated by pilots and validated by eye tracking technology. The application of touchscreens in the flight deck must be consistent with human factors principles on cross-monitoring and integrated information to improve usability and safety in flight operations.

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