Assessing pilots' situation awareness using touchscreen inceptor

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SUMMARY

This research aims to investigate the innovative technology of touchscreen inceptor impact on pilots' situation awareness compared to a traditional sidestick. The Pupil Lab eye tracker collected pilots' fixation counts in the Future Systems Simulator (FSS), and subjective measure was the situation awareness rating technique (SART). A significant difference was spotted in the attention demand, understanding, and total score from SART analysis. Furthermore, the visual parameter of fixation counts indicated that pilots spent less time on OTW and more time on PFD when interacting with the touchscreen inceptor compared to the sidestick. The findings show the potential to implement a touchscreen in future flight deck designs.

KEYWORDS

Flight Deck Design, Human-Computer Interaction, Situation Awareness, Touchscreen Inceptor

Introduction

Effective hand-eye coordination and no extra space required features made touchscreens one of the most welcomed technologies in daily use. Technology can mimic the mechanical components via the display and present the potential for reducing pilots' task loads by interacting with practical human-computer interface design (Korek et al., 2022). While interacting with a touchscreen, human operators were not required to fixate on other displays to search for the consequences of their inputs compared with traditional mechanical knobs/levers on flight decks. The replacement of touchscreens has the potential to reduce training time and cost; however, its impact on aircrew's performance must be thoroughly examined before introduction (van Zon et al., 2020). Therefore, this study aims to extend the potential of using the touchscreen as an inceptor to explore the potential issues of human-computer interaction in the future flight deck.

Methods

Ten participants aged 22 to 46 (M = 29.6, SD = 7.8) with flying experienced (M = 695.7, SD = 1001.7) were involved in the experiment. The future systems simulator (FSS) was utilized, as it allowed the use of both touchscreen and sidestick flight inceptors on instrument landing scenarios. Participants were asked to conduct an instrument landing using a sidestick and touchscreen inceptor wearing an eye-tracking device. Automation systems controlled the speed and rudder to simulate the highly automated flight deck and mitigated deviation. There are three areas of interest in the FSS, including "out of the window" (OTW) view, navigation display (ND), and the primary flight display (PFD). Pilots' situation awareness was measured with SART, which consists of ten questions in three dimensions (supply, demand, and understanding) from zero (low) to seven (high) (Taylor, 2017).

Result

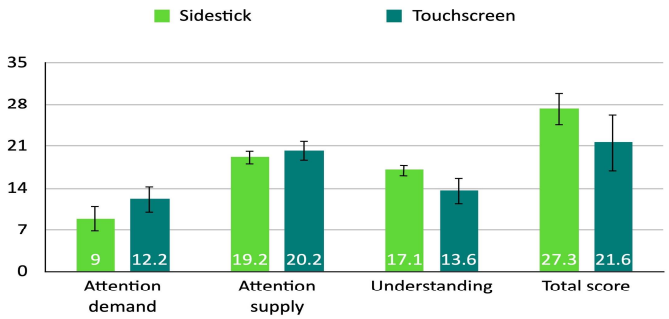

Figure 1: SART scores

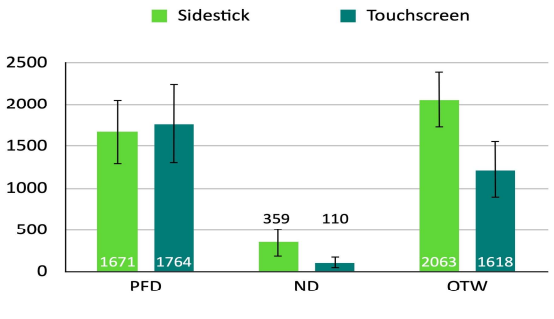

Figure 2: fixation count in displays

Figure 1: SART results

The result of SART demonstrated that attention demand is significant, $t(10) = 3.28$, $p = 0.04$, $d = 1.04$, and significance on understanding, $t(10) = 3.41$, $p = 0.003$, $d = 1.08$. There is no significance on attention supply, $t(10) = 0.73$, $p = 0.24$. However, there is a significance in SART total score, $t(10) = 2.37$, $p = 0.02$, $d = 0.75$ (figure 1). The visual parameters demonstrated no significance on fixation counts on PFD, $t(10) = 0.47$, $p = 0.32$. However, pilots' fixation counts were significantly less on both ND, $t(10) = 2.04$, $p = 0.04$, $d = 0.65$, and OTW, $t(10) = 4.47$, $p = 0.0008$, $d = 1.41$ while interacting with a touchscreen compared with sidestick (figure 2).

Discussion & Conclusion

When a touchscreen is used as an inceptor to manipulate the aircraft landing, the system demand on the attentional resources from pilots and supply of attentional resources to pilots is higher than sidestick. However, pilots' understanding of the situation could have been higher, possibly due to the innovative functions of touch-control overlapping with PFD with critical information, such as airspeed, altitude, heading and glideslope. Therefore, pilots' total SART scores were significantly lower on touchscreen interaction than on sidestick (figure 1). Furthermore, pilots' visual attention on OTW and ND showed significantly fewer fixation counts on the touchscreen. The significantly reduced fixation counts on OTW indicated that pilots head-down time significantly increased while interacting with the touchscreen. This may negatively impact pilots' SA performance, as pilots could not perceive the dynamic changes of the surrounding environment. Although the fixation counts on the PFD did not show a significant difference (figure 2), their fingers blocked the critical information related to airspeed and altitude while interacting with the touchscreen. Changing the touchscreen layout may be a solution, for example, by installing the touchscreen inceptor in a suitable place, which can eliminate the operational risk of obstructing critical information.

Touchscreen inceptors may provide potential benefits for further development, though their application is still in the infancy stage and is not yet ready for implementation in the flight deck. This study suggests that introducing a touchscreen as an inceptor in a flight deck needed further consideration of potential human factors issues. Human-computer interactions and user interface design can help the technology be more suitable for human-centred design and enhance the chance of successfully integrating touchscreen inceptors into future flight decks.

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