Augmented Design with Voice Recognition and Auditory Alerts in the Flight Deck

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SUMMARY

Devices using voice recognition and verbal auditory alerts have advanced rapidly in the modern world. In an era that drives the world using voice commands, aviation has lagged to implement this technology in cockpits. Contrary to the rapid pace of advancements in cockpit instruments, auditory alerts have also been largely primitive. With such technologies gaining rapid acceptance in many industries, it is about time to consider adopting the same in cockpits, especially to support pilots during enhanced operational workload. This paper conducts a use case study on the prevailing aural technologies in the cockpit whilst exploring the augmentation of contemporary technologies in voice recognition and verbal auditory alerts to aid pilots' cognition and reduce mental workload.

KEYWORDS

Augmented Reality, Cognitive Support, Semantic Alert, Situation Awareness, Voice Recognition

Introduction

From adopting glass cockpits to substituting cockpit crew with avionics, cockpit technologies have evolved rapidly benefitting aviation safety and enhancing the piloting experience. However, the usage of auditory alerts has largely been primitive whilst the use of voice recognition is practically non-existent in civil aviation. The use of navigation systems with verbal auditory alerts in the automotive industry has helped drivers experience enhanced cognition and situation awareness whilst reducing mental workload. During a dynamically changing environment, it is pivotal for pilots not to lose situation awareness whilst constantly shuffling to perceive information from the cockpit displays and the outside environment. The judicious use of verbal auditory alerts and voice recognition in tandem with artificial intelligence can positively impact cockpit dynamics and improve cognition leading to enhanced flight safety (Lin et al., 2022).

Augmenting Voice Recognition

Voice recognition in cockpit purposes to serve pilots' commands to be interpretable by the flight computers. This technology has made its way into the military cockpits of Eurofighter (Smith, 1999) and Lockheed Martin F-35 (Schutte, 2007) to facilitate pilots to conduct operations in highly dynamic environments by alleviating operational workload. Speech synthesis technology is employed in operating autopilot modes and aircraft configuration whilst also performing cockpit functions such as operating buttons, levers, and switches supplementary to manual inputs. However, voice recognition has lagged to commence in civil aviation. With the advancements of technology in avionics, the complexity of the human-machine interface keeps escalating the operational perplexity for pilots leading to a higher mental workload and loss of situation awareness.

Acoustic alerts versus synthesized speech

Acoustic alerts have been tolerably functioning in cockpits as transient auditory signals to alert pilots of impending dangers or adverse changes in the aircraft's configuration and performance. These sounds do not however impart an intuitive link between the alert and its target function thereby imposing an initial learning curve to comprehend the aural taxonomy. Synthesized speech, unlike acoustic sounds, is nimble to be assimilated. However, scant synthesized speech alerts are in existence. Considering the multitude of alerts required by the pilots to maintain situational awareness, it is ergonomically congruent to instate synthesized verbal alerts to keep the pilots informed of the various modes and states of the aircraft systems. Additionally, whilst synthesized speech is combined with acoustic alerts to deliver critical information, a shorter time is required for cognition (Kearney et al., 2016).

Use Case

Human-computer interaction systems using augmented reality such as Microsoft HoloLens with voice command can aid in reducing physical demand and cognitive load whilst increasing situation awareness (Li et al., 2022). Supplementary to voice commands, gaze commands could also be implemented owing to its resistance to unintentional activations, and the minimized workload and reduced time required to accomplish the required action (Isomoto et al., 2020). Augmenting visual cues in tandem with aural annunciations to propagate the required information can prevent inadvertent operations and misconfiguration of the aircraft (Conner et al., 2012). Implementation of the HoloLens in a cockpit environment (see fig. 1) can be devised to safeguard checklists during pilot performance degradation triggered by enhanced operational workload and a dynamically changing environment. This use case demonstrates that such technologies could improve the pilot's safety and efficiency during crucial phases of flight by ensuring acceptable levels of performance without omission of actions. The holographic features of the HoloLens in combination with voice commands, gaze commands, and synthesized speech can optimize the efficiency and safety of the flight by:

- Providing a step-by-step list that is predominantly on the pilot's line of sight
- Displaying components requiring action when a checklist task is enunciated
- Ensuring that the correct action has taken place in accordance with the checklist
- Automatically switching over to the next task on the checklist

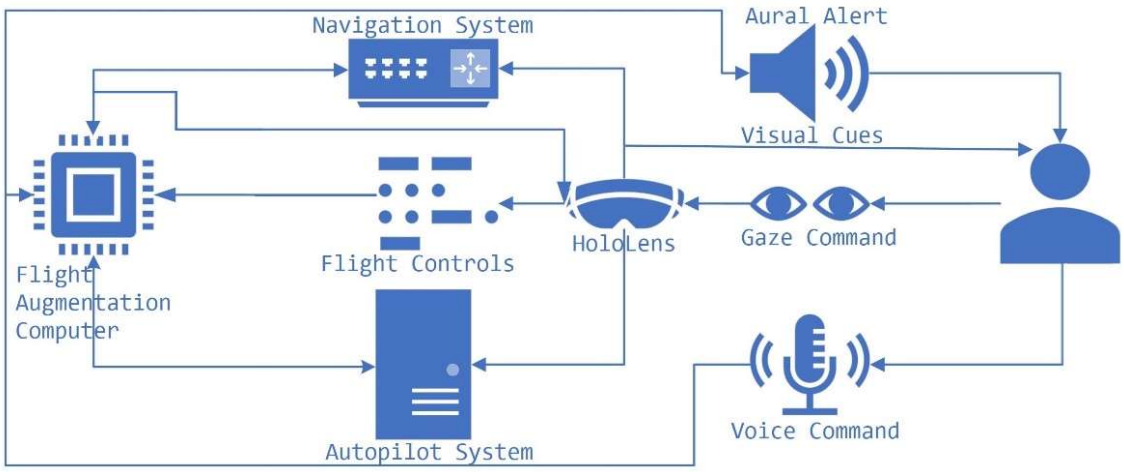

Figure 1. Use case of voice command and gaze command with an augmented reality device

Conclusion

Successful implementation of augmented support to pilots either voice commands or gaze-command will be a potential solution for the future single-pilot flight deck. Furthermore, the augmented reality device has to be able to recognize variations in speech prosody and speech from a comprehensive vocabulary which can reduce the pilot's mental workload. The saliency of visual and auditory messages on both inputs and outputs in the flight deck requires further investigation to support single-pilot operations in the future.

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