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Perceptions of Thai Aviation Students on Consumer Grade VR Flight Experiences †

Jeremy Luisier [1]*, Soemsak Yooyen [2] and Samart Deebhijarn [3]

[1] Affiliation 1; jeremy.lu@kmitl.ac.th, International Academy of Aviation Industry, King Mongkut's Institute of Technology Ladkrabang, No. 1, Soi Chalongkrung 1, Ladkrabang, Bangkok, Thailand 10520
[2] Affiliation 2; soemsak.yo@kmitl.ac.th, International Academy of Aviation Industry, King Mongkut's Institute of Technology Ladkrabang, No. 1, Soi Chalongkrung 1, Ladkrabang, Bangkok, Thailand 10520
[3] Affiliation 3; samart.de@kmitl.ac.th, College of Educational Innovation Research, King Mongkut's Institute of Technology Ladkrabang, No. 1, Soi Chalongkrung 1, Ladkrabang, Bangkok, Thailand 10520
*Correspondence: jeremy.lu@kmitl.ac.th; jeremy.kmitl@gmail.com; Tel.: +66 (0)61 774 0482
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Abstract: With extended reality (XR) technology on the rise in aviation education, we evaluated the perceptions of Thai students on an inexpensive and classroom-friendly virtual reality (VR) system and software combination, as an introduction to flying an aircraft. In addition to cost-effectiveness, consumer grade technology also provides greater portability than traditional full-flight simulators. Third year aeronautical engineering and commercial pilot undergraduate program international students were exposed to a brief VR experience using a PlayStation 4 console (PS4) with PlayStation VR (PSVR) and Ultrawings software. Subsequently, in-depth qualitative interviews were analyzed via thematic coding. The student responses were mostly positive and enthusiastic, but also identified issues with hardware and software (screen door effect, limited peripheral vision, less than optimal interaction controls, and lack of haptic feedback). Using thematic coding, responses were categorized into; head mounted device, controls and controllers, plausibility illusion, place illusion, embodiment illusion, academic value and entertainment value. Following respondents' positive responses on certain identified critical points, we recommend further study using other hardware and software combinations.

Keywords: aviation; education; extended reality; virtual reality

1. Introduction

With virtual reality (VR) systems like PlayStation4 (PS4)/PlayStation VR (PSVR) and the Oculus Quest becoming more affordable, aviation education programs are now able to bring aviation-related flight software into standard classrooms. This makes immersive virtual reality flight experiences more widely available, especially in Thailand and other developing ASEAN countries. Accessible VR flight programs relieve academic institutions of possible budget and space concerns associated with advanced flight simulators, for example, those manufactured by Redbird Flight Simulators, Inc. [1].

We collected qualitative data on the perspective of knowledgeable aeronautical engineering and commercial pilot students regarding consumer grade VR flight experiences. In the research design, particular consideration was given to Slater's conceptual framework for virtual reality, namely plausibility illusion and place illusion [2]. However, other concepts and themes were allowed to emerge naturally in the interviews.

2. Methods

Three third-year aeronautical engineering and commercial pilot undergraduate program international students from Ladkrabang district of Bangkok, Thailand were guided through a seated

virtual reality flight experience using PS4 [3] with DualShock controllers and PSVR CUH-ZVR1 Series [4] hardware with Ultrawings [5] flight software. Initial questions aimed to establish the students' state of mind and eliminate variables such as extraordinary stress, hunger, or fatigue. Participants were briefed on procedure, safety, and equipment before beginning a 15 minute VR session. An attendant researcher monitored closely and the research setting was prepared to minimize interruptions and provide reasonable comfort.

Following the VR experience, participants were asked questions in a conversational format. The researcher conducting the interviews occasionally added questions for clarification or probing, and offered gentle guidance to remain on topic. The interviews were recorded and transcribed using the Otter application for Android and the researcher revised transcription errors in accordance with the audio files and field notes. Interviews lasted approximately 10-15 minutes and began with 9 pre-planned questions. Conversations were allowed to flow normally, allowing for additional follow-up questions and comments by all parties.

3. Results

The researchers' thematic analysis of the qualitative interview transcripts, audio recordings, and field notes was validated between the researchers and resulted in seven emergent themes. The themes were; head mounted device, controls and controllers, plausibility illusion, place illusion, embodiment illusion, academic value, and entertainment value. Details of the responses on each theme follows.

3.1. Head Mounted Device (HMD)

The student respondents' repeatedly cited low-resolution with the PSVR HMD as a leading detractor from the virtual reality experience. Respondents also noted that reducing the screen door effect (SDE), or unlit space in between LED pixels that causes the user to view the virtual surroundings as if through a screen door mesh [6], would improve the experience.

3.2. Controls and Controllers (CC)

Participants found that the PS4 DualShock controller with thumb pads was not realistic enough. They liked the simple and easy to use controls - easier than a QWERTY keyboard - but reported a joystick (or other controls more similar to those found in a real aircraft) would be preferable.

3.3. Plausibility Illusion (PsI)

Overall, respondents reported that the Ultrawings virtual reality experience was plausible -"like being in the real situation" and "felt like flying". The only detractor was lack of haptic feedback, a known limitation of the study: with the PS4/DualShock controller setup, the only haptic feedback was simple controller vibration [7].

3.4. Place Illusion (PI)

There were two main reasons reported for breaks in PI, both directly related to the software, Ultrawings. The first issue was peripheral vision. When the participant or player was looking straight forward, the left and right sides of the virtual ultra-light aircraft were blacked out. When the participant turned his or her head, the slight delay before the environment appeared caused breaks in PI. The second issue reported was the aesthetic of Ultrawings. One respondent reported that the bright, cartoonish style made it difficult to believe she was actually in the environment.

3.5. Embodiment Illusion (EI)

Respondents reported that it would be beneficial and desirable to have embodiment illusion in the simulation game. Such an illusion is possible with a virtual body, of which a user may develop a feeling of ownership [8]. However, in the PS4/PSVR Ultrawings version used here, there was no virtual body. Interaction was gaze-based - objects were selected in coordination with the participant

line of sight. This was a known study limitation. Students reported a desire to see "their" virtual hands, in order to manipulate buttons, levers and other controls more naturally.

3.6. Academic Value (AV)

Respondents candidly discussed the place they saw for a virtual flight experience in an academic setting. They noted that hardware like PS4/PSVR was inexpensive, accessible, and suited a classroom with limited space. One participant reported that the simulation game, Ultrawings, or software like it, would be useful to teach the chronological procedures in preparation and operation of an aircraft. Respondents found the experience to be more immersive than a 3-monitor setup and reported it as a good potential predecessor to the Redbird flight simulator training that takes place in the undergraduate program's fourth year. They had observed the Redbird flight simulator but not yet used it.

3.7. Entertainment Value (EV)

All respondents reported an overall positive experience with the PS4/PSVR and Ultrawings combination. They found the experience "interesting", "impressive", and reported that the experience made them feel good. The field researcher noted that participants were notably exhilarated, smiling and happy after the 15 minute virtual reality session. Participants were eager to discuss their experiences during the interview and provided feedback with ease despite reporting in English, a second language for these Thai international program students.

4. Discussion

Considering the pros and cons arising from the student responses, we identified multiple options for improving the overall VR flight experience, including making changes to the hardware or software used, or both.

The SDE can be reduced or eliminated by utilizing VR equipment available at the next consumer tier. Upgrading to the next tier would increase costs, but still use equipment in the range of consumer grade products. Next tier HMDs also offer higher resolution than the PSVR, which offers 960 x 1080 pixels per eye compared with Oculus Quest's 1440 x 1600 [9] or HTC Vive's 1080 x 1200 [10].

The Ultrawings software is available for other consumer grade VR devices on the Steam platform. At the time of writing, Steam offers Ultrawings support for Valve Index, HTC Vive, Oculus Rift, and Windows Mixed Reality devices [11]. In addition to increased resolution, these devices also offer an array of different controllers and controller designs. Future studies could compare and contrast the use of Ultrawings on various devices.

Haptic feedback is still limited in consumer grade VR devices, though this will likely continue to improve as new devices and accessories are introduced. Improved haptic devices and haptic feedback would improve PsI. PlayStation's blog reports that PlayStation 5 will include improved haptics that allow the user to sense differing textures [12].

PI could be improved by other VR flight software or versions of Ultrawings with more realistic graphics. Other software could include virtual hands or a virtual body to give the user a sense of EI.

Student comments on academic value indicated that they were confident such virtual reality flight experiences had a place in an aviation-related curriculum and comments on the entertainment value indicated that using these experiences could lend to better satisfaction and engagement. Various combinations of hardware and software can be explored to maximize these benefits. Creation of comparable custom software is also a possibility, given appropriate resources. Researchers have reported positive outcomes following this path for aviation-related teaching and learning [13].

5. Conclusion

Data provided by student respondents supported further study of consumer grade virtual reality experiences in aviation-related learning. We recommend future research to explore different hardware and software combinations to compare and contrast data on the themes of HMDs, controls

and controllers, plausibility illusion, place illusion, embodiment illusion, academic and entertainment value.

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References

1. Redbird Flight Simulators, Inc. Available online: https://simulators.redbirdflight.com/products/topic/simulators (accessed on 18 November 2019).
2. Mel Slater. Place illusion and plausibility can lead to realistic behaviour in immersive virtual environments. *Phil. Trans. R. Soc. B 2019*, 364, 3549–3557. doi:10.1098/rstb.2009.0138
3. PlayStation 4 Specifications. Available online: http://us.playstation.com/ps4/features/techspecs/index.htm (accessed on 18 November 2019).
4. CUH-ZVR1 Full Specifications. Available online: https://www.playstation.com/en-us/explore/playstation-vr/tips-and-specs/#cuh-zvr1 (accessed on 18 November 2019).
5. Ultrawings. Available online: http://ultrawingsgame.com (accessed on 18 November 2019).
6. VR Vision Group. Available online: https://vrvisiongroup.com/what-is-the-screen-door-effect-why-does-it-happen/ (accessed 18 November 2019).
7. Minamizawa, Kouta & Prattichizzo, Domenico & Tachi, Susumu. Simplified design of haptic display by extending one-point kinesthetic feedback to multipoint tactile feedback. 2010 IEEE Haptics Symposium, *HAPTICS 2010*. 257 - 260. 10.1109/HAPTIC.2010.5444646.
8. K. Kilteni, R. Groten, & M. Slater. The Sense of Embodiment in Virtual Reality. *PRESENCE: Teleoperators and Virtual Environments 2012*, 21, 373-387.
9. Forbes Media, LLC. Available online: https://www.forbes.com/sites/solrogers/2019/05/03/oculus-quest-the-best-standalone-vr-headset/#4904a0fd8ed8 (Accessed 18 November 2019).
10. HTC Corporation. Available online: https://www.vive.com/us/product/vive-virtual-reality-system/ (accessed 18 November 2019).
11. Valve Corporation. Available online: https://store.steampowered.com/app/639130/Ultrawings/ (accessed 18 November 2019).
12. Sony Interactive Entertainment. Available online: https://blog.us.playstation.com/2019/10/08/an-update-on-next-gen-playstation-5-launches-holiday-2020/ (accessed 18 November 2019).
13. Mohammad Anuar Yusof, Abdul Malek Ya'acob, Mohd Azman Mohd Zaki, Zuriana Abdul Rahman, Nurul Husna Zainol Abidin, Irna Fazana Padil, Muhd Khudri Johari, Ismail A. Bakar, Hanif Faiq Mohd Hashim. Developing a Virtual Reality (VR) App for Theory of Flight & Control as a Teaching & Learning Aid. *IJITEE 2019*. *Volume-8 Issue-6S*. ISSN: 2278-3075.