Virtual and Augmented Reality for Cabin Crew Training: Practical Applications

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VR/AR for Training in Aviation

• “Virtual Reality (VR)”… “Augmented Reality (AR)”… “Serious Games”:  
  – The “next big things” in aviation training?  
  – Be wary of hype without substance!

• **Scientific studies are needed to:**
  – Assess actual effectiveness  
    • “Do they work?”, “What are they useful for?”, “Can they be better than current methods?”,…  
  – Explore the design space  
    • “Which specific designs and features work?”, “And which do not?”, “How should we do it right?”,…

• Since 2013, this has been the main focus of several research and development projects at our lab, also supported by FAA grants
Serious Games on the official FAA site
www.faa.gov/data_research/research/med_humanfacs/aeromedical/cabinsafety/passengerinfo/
Our Human-Computer Interaction Lab (HCI Lab)

- Multidisciplinary approach:
  - combining psychology/neuroscience and IT/computer science expertise to...
  - ...design and develop applications for human use that are proven effective
- Active since 1998 (more than 100 man-years of research and development)
- Specialized in:
  - Training, Learning, and Education
  - Safety, Security, and Emergencies

Luca Chittaro – EATS 2018
http://hcilab.uniud.it/aviation
This presentation demonstrates some of the VR/AR training applications we have built, and summarizes key results we obtained in user studies

- **Research and applications @ HCI Lab (2013-2017, also with FAA grants support)**
  - Learn to Brace, Life Vest, Emergency Water Landing VR, Prepare for Impact, Air Safety World
  - Contrasting the effectiveness of these VR applications vs. traditional training materials

- **Latest results (2018):**
  - Contrasting the effectiveness of different types of VR hardware for procedural cabin training

- **New, practical applications to Cabin Crew Training @ AVIETRA (2017-2018):**
  - Aircraft and Cabin Familiarization
  - Galley Familiarization
  - Pre-Boarding and Pre Take-Off Checks
  - Door Training
  - Emergency Evacuation Training
  - Security Training (cabin search, unruly passengers,...)
The “Learn to Brace” project
(Knowledge Increase and Locus of Control)

- In recent years, the FAA conducted dynamic impact tests that led to identify improved brace positions (DOT/FAA/AM-15/17, 2015).
- Under a FAA grant, we created and studied a mobile simulation game that teaches the new brace positions.
- In April 2014, the game was publicly released for all major mobile platforms (250,000 installations as of May 2018). To download it, see http://hcilab.uniud.it/brace.

Main Findings:
+ larger knowledge gain
+ improved feeling of control over emergencies than traditional materials.

The “Life Vest” project
(Training Transfer, Efficiency, Human Error)

• In recent years, the FAA conducted tests of life preserver donning illustrations, showing that they are difficult to comprehend (DOT/FAA/AM-14/14, 2014)

• Under a FAA grant, we created and studied a mobile 3D app that teaches how to don a life preserver

• In January 2015, the app was publicly released for all major mobile platforms (92,000 installations as of May 2018). To download it, see http://hcilab.uniud.it/lifevest

• **Main Findings.** The app produced:
  + faster donning time in the real world
  + less errors in the real world
  + more engagement than traditional materials.

The “Emergency Water Landing VR” project
(Memory Retention, Emotions, and Physiological Reactions)

- Study of different effects of using our immersive “Emergency Water Landing VR” system of a cabin emergency scenario
- Scenario based on US Airways flight 1549 (NTSB report AAR-10/03)
- Players can try any (correct or wrong) action and see its effects, including the most scary ones

**Main Findings:**
+ better knowledge retention after 1 week
+ larger emotional engagement, both self-reported and physiologically measured than traditional materials.

The “Prepare for Impact” project

• Goals:
  – Comprehensive set of realistic cabin safety scenarios described in real-world accident reports
  – Complex simulations on smartphones and tablets, making the game playable by a very large user population
  – Supporting competition among game players
  – Collecting telemetry data from a massive set of online players for in-depth data analytics

The Impact of “Prepare for Impact”

• Released in March 2016 (to download it, see http://hcilab.uniud.it/impact/)

• The most successful serious game so far:
  – 4 MILLION installations as of October 2018
  – keeps growing at a rate of more than 3,000 new installations per day

• A large effort was required to research, design, develop, evaluate, and deploy the serious game in the right ways
The “Air Safety World” project

• Recently released and rapidly growing (about 500,000 installations in the first 12 months)

• Described as ‘perfect app’ by Australia’s Civil Aviation Authority (CASA) flight safety magazine

• To download it, see http://hcilab.uniud.it/impact/
AVIETRA: VR/AR for Airlines

- We created the company specifically to address airlines' VR/AR needs
- AVIETRA stands for AVIation Education and TRAining (www.avietra.com)
A well-designed VR training system must:

• vividly simulate any type of normal or emergency scenario with any low-cost VR headset

• Maximize:
  • realism
  • engagement
  • usability
  • knowledge retention
  • resilience
Room-size VR Interaction DEMO

Room-size VR solutions track:

- Head
- Both hands
- Positions in the room

Room-size VR headsets need connection to a VR-ready PC
Current portable VR solutions track:

- Head (orientation, not position)
- One hand (orientation, not position)

Portable VR headsets do not require to set up a room, and do not require a PC
Headsets are not always the best choice:

- Some trainees prefer to conveniently experience the 3D training on the touchscreen of their smartphones and tablets, at any time and place.
Importance of a Multiplatform Architecture

AVIETRA VR Engine → Smartphones and Tablets
AVIETRA VR Engine → Portable VR systems
AVIETRA VR Engine → Room-size VR systems

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Effectiveness of different VR displays on training
(Memory Retention, Self-efficacy, Engagement, Immersion)

- **Participants**: 96 (55 M, 41 F)
- **Age**: from 18 to 36 (Mean=23.81)
- **Limited previous cabin safety knowledge**, flights (last 2 years): from 0 to 15 (Mean=3.03)
- **Procedure**: Three VR groups: one used a non-immersive display (27” PC Monitor), the other two groups used immersive displays (one used an HMD with narrower FOV and head orientation tracking, one used an HMD with wider FOV and head orientation+position tracking)
- **Main Findings** (statistically significant):
  - **Engagement and Presence**: significantly affected by display type
  - **Knowledge and Self-efficacy gains**: obtained, and maintained at 2 weeks, regardless of the display type used
- **Study limitation**: tested only **procedural knowledge**, other kinds of knowledge (for example, spatial knowledge) will be the subject of additional studies

Augmented Reality (AR): Cabin Search DEMO

Different AR technologies
- AR Goggles and AR HMDs, (for example Hololens): still limited in their field of view, costly
- AR on Smartphones and Tablets: much cheaper, more practical to use at any time and place

AR does not work well in certain environmental conditions, for example low light or highly reflective surfaces
Virtual instructors can:
- Guide the trainee to explore the cabin
- Inform about equipment and operation
- Provide feedback about the trainee’s actions
- Ask test questions
- Provide feedback about the trainee’s answers

The trainee can also explore the cabin freely and operate equipment
Galley familiarization DEMO

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Security – Unruly Passenger DEMO

Virtual Reality (VR) Version
Security – Unruly Passenger DEMO

Augmented Reality (AR) Version
Limitation of VR door training:
- No physical forces

Advantages of VR door training:
- Wider, richer range of scenarios can be simulated, with high realism
- An airline can have a large number of virtual door trainers available for any aircraft door
- If the VR door trainer is on personal mobile devices, trainees can use any door trainer, anytime, anywhere
Simulating Equipment Faults DEMO

Any equipment fault and its effects can be simulated, the trainee can try the procedures needed to manage the fault.

Examples:
- power assist failure
- door stuck
- slide does not deploy
- slide does not inflate
- ...

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Any environmental conditions and hazards can be simulated, and the trainee can try the procedures needed to manage the situation.

Examples:
- Cabin pressure indicator flashing
- Different environments (airport, open field, sea,...)
- Fire outside or inside
- Debris and obstacles outside
AR/VR in airline digital transformation

- 3D assets created for one airline department must be re-purposable for other departments in digital transformation strategies

- **Case study 1: Marketing**
  - Virtual prototyping of cabin designs (and testing on customers)
  - Promotion of the different classes of service to customers through VR

- **Case study 2: On-board information**
  - Generation of 3D photorealistic IFE tutorials for the aircraft on-board features/services
  - Generation of 3D photorealistic IFE safety videos
AR/VR in airline digital transformation (VIDEO)
Summary and on-going studies

- The international, published studies of our applications on different VR platforms show that they improve:
  - Learning
  - Knowledge retention
  - Knowledge transfer
  - Engagement
  - Efficiency
  - Error prevention
  - Personal resilience factors, such as perception of control over emergencies (internal LOC) and self-efficacy

- We are currently completing studies that compare the effects of:
  - different VR types (immersive vs. non-immersive, room-size vs. portable)
  - different presentation types (for example, features of virtual instructors)