INTEGRATED FLIGHT DECK TESTBED WITH NEXT GENERATION VISUAL DECISION SUPPORT TOOLS

Mevlüt UZUN

Istanbul Technical University
Controls and Avionics Laboratory
Aeroanutics Research Center

27/05/2014
Outline

- Need for decision support tools
- Integrated testbed: Flight deck simulator and ATM testbed
- Visual flight deck decision support tools
  - Next generation synthetic vision
  - Augmented reality based visualization technologies
- Next generation synthetic vision screens
- Augmented reality based Head-up Display
Introduction

- Transition from centralized tactical intervention model to a more efficient strategic planning (SESAR Conops, NextGen Conops)
- Determine best decision place, best decision time and best decision player (SESAR WP-E HALA! Position Paper)
- The crew cannot be expected to perform a complex task without some new form of automation and dst

New role assignment based on:

First dimension “BEST TIME” for decision making: Strategic vs. tactical planning layer
Second dimension “DECISION PLACE”: Controlled vs. autonomy.
Third dimension “BEST PLAYER”: Human vs. automated player.

SESAR WP-E HALA! Position Paper
Introduction

- Situational Awareness
  - Automation complacency
    - Pilot falls out-of-loop due to over-trust in the system
    - Diminishes the pilot’s ability to recover from automation failure
  - Unreliability to the automation
    - Gives excessive attention to monitor the automation
    - Diminishes SA with high workload
  - Fully transparent system
    - The pilot may be led to attend to too much and too low level system information, resulting high workload and diminished situational awareness
Attention tunneling
- The pilot perceives the automation to be unreliable and gives excessive attention to Monitor the system, SA diminishes with a high workload
- American Airlines 965 Flight
What should be expected from a good DST?
- Provide transparency at a manageable workload level
- Allow the pilot to be in the loop in a cooperative manner
Integrated testbed: Flight deck simulator and ATM testbed

- Envisioned to validate innovative add-on avionics and features come into the flight deck automation systems in order to meet the requirements of the future flight operations.

- Levels of automation
  - Collaborative mid-term trajectory planning
  - Short term collision avoidance
Integrated Testbed: Flight deck simulator & ATM testbed
Integrated testbed: Flight deck simulator and ATM testbed
Visual flight deck decision support tools

- Next generation synthetic vision
  - Synthetic Visition Display for low-level flight operations
  - 4D Operatinal Display for high-level trajectory planning operations
- Augmented reality based visualization technologies
  - Head-up Display

- What do these tools aim?
  - Aid pilots for conducting their new in-flight tasks such as
    - Collaborative tactical planning with intent negotiation and sharing
    - Fully understanding solution with their new alternatives
    - Proposing modification on the solution subject to negotiation
    - Aware of required response
Main objectives of these tools:

- 4D Flight Management + Operational Management Display
  - Support pilots in managing both low level and high level tactical tasks with fully understanding the situation in 4D
  - SVD side: Incorporates required guidance and operational information with synthetic vision concept – short term tactical
  - 4D Operational Display: Provides higher level operational information giving enhanced understanding on the states of the operation and results of any modification on processing flight intent – long term tactical
Next Generation Synthetic Vision Screens

- Envisioned to provide the pilot with full understanding on the evolving flight operation and effects of any intervention

- Supported information
  - Objectives of the operation (intent trajectory, RTA objectives, delays, primary flight information)
  - The environment (surrounding traffic, potential loss of separation, proximity to terrain)

- Functionality
  - SVD screens enable required interaction to accept, modify or request re-planning during the intent negotiation process and demonstration
Synthetic Vision Display

- SVD: Pilot can operate the entire flight without having to look up in case of the low visibility flight operations

- Supported Information
  - Incorporates additional guidance and operational information
  - Standard motion related information such as airspeed, vertical speed, altitude, flight directory
Synthetic Vision Display

- **Functionality**
  - Tunnel visualization gives a continuous perception across the whole trajectory from surface operation to landing with glide slope.
  - In addition to synthetic visualization, it also enables to visualize the weather through the METAR data.
  - Other soft obstacles such as closed airspace, airspace constrained altitude levels and high loaded traffic volumes.
4D Operational Display

- **4D Operational Display:** Supported Information
  - Surrounding aircraft in four dimensions
  - Environmental effects such as weather, airspace boundaries, terrain obstacles
  - Status of the flight involving RTA objectives, delays, estimated capacity of the airspace
4D Operational Display

- Functionality
  - Pilots can monitor the flight trajectories (negotiated or processing) of the ownship.
  - Flight crew can also monitor future projection of the trajectories using the time slider button on the screen or initiating fast simulation of the flight.
- Succeeded negotiation
  - The negotiated intent can be executed autonomously via FMS
  - Pilot can choose to follow the trajectory manually with guidance of the tunnel-in-the-sky visualization on SVD
Visual flight deck decision support tools - HUD

- Head up display
  - Provides pilot to efficiently operate flight operation
  - Aims to present all essential flight information in the pilot’s forward field through augmented reality implementations
    - Low visibility flight operations
Augmented reality based Head-up Display

- **Supported Information**
  - Provides informational summary about the transient status of the flight including near term objectives
  - Presents flight path marking, speed and altitude meters, glide slope angle

- **Functionality**
  - Demonstrates negotiated continuous trajectory through tunnel in the sky obtained through a combination of all tactical level information, all come from FMS
  - Aims to make pilot able to operate the entire flight by following the demonstrated virtual tunnel ensuring safety
  - Enables to demonstrate text based pop-up message boxes to give high level status information – RTA box, Delay box, FMC commands
Augmented reality based Head-up Display
Experiments

http://www.youtube.com/watch?v=UuMh75Dh6YU
Conclusion

- A multi-mode flight deck testbed structure with add-on visual decision support tools—Synthetic Vision Display pair & Head up Display—is presented.

- Synthetic vision display includes two separate screens and envisioned to provide the pilot with full understanding on the evolving flight operation and effects of any intervention.
  - Synthetic vision flight with tunnel-in-the-sky concept
  - Operational management: Envisioned to increase transient SA and enhance fully understanding the entire flight operation, flight crew can manage flight intent negotiation.

- Head Up Display aims providing pilot to efficiently transition from head-down to head-up, presents all essential flight information in the pilot’s forward field through AR implementations.

- An integrated B737-800 flight deck simulator and ATM testbed has been customized for hardware integration and experimental purposes, enabling operational tests and validations of new tools.
Future Work

- Development of the introduced algorithms that are amenable to the rigorous certification process implemented and executed by the aviation agencies in the U.S. And in Europe.

- To build a test and validation platform on the integrated flight deck and ATM simulation system of ITU in order to perform human factor related tests to these tools for further improvements.
Thank You!