What is a Vision System?

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Vision Systems Components Terminology

- EFVS = Enhanced Flight Vision System
- H-EFVS = Helicopter Enhanced Flight Vision System
- HUD = Heads-up-display
- HWD = Head-worn-display
- HMD = Head-mounted-display
- NVG = Night Vision Goggles
- EVS = Enhanced Vision System (EVS uses sensor imagery (i.e. infrared cameras or millimeter wave radar or LIDAR) to display features like runway obstructions and terrain in bad weather or on a dark night)
- SVS = Synthetic Vision System (SVS uses information from a look-up database (i.e. terrain, airports/heliports) to create an artificial rendering of the outside world)
- CVS = Combined Vision System (CVS combines elements of EVS and SVS imagery to create a fused image of the flight environment)
Enhanced Flight Vision Systems (EFVS)

- EFVS = An installed aircraft system that uses a HUD or equivalent display to present:
  - Aircraft Information, Flight Symbology, Electronic real-time sensor image of the forward external scene *(Note: Imaging sensors can be forward-looking infrared, millimeter wave, radiometry, millimeter wave radar, low-light level image intensification or other real-time imaging technologies)*
Helicopter Enhanced Flight Vision Systems (H-EFVS)

- H-EFVS = An EFVS system for helicopters consisting of a HWD/HMD/HUD (as shown below) with rotorcraft symbology and sensor imagery

Sensor & Computer + Display = H-EFVS

(FLIR, MMWIR, LIDAR, etc.) + (HWD, HMD, HUD, HDD, etc.)
Heads-Up Display (HUD)

- HUD: Heads-Up Display with flight symbology and SVS, EVS, and/or CVS information overlaid at various levels of transparency with the outside visual scene
Head-Worn Display (HWD)

- HWD: Essentially a HUD but wearable by the pilot, capable of rendering the same information as a fixed HUD but information moves with the pilot’s head.
Helmet-Mounted Display (HMD)

- HMD = Same as an HWD but the display is mounted to the helmet, some devices can be used with Night Vision Goggles (NVG’s) and some cannot
Night Vision Goggles (NVG)

- NVG: Work to illuminate the external scene at night via light amplification and traditionally are available in green or white phosphor monochrome color. (Note: NVG’s are not currently approved for IFR operations in the U.S.)
Enhanced Vision System (EVS)

- EVS: Enhanced Vision Systems use sensor imagery (i.e. infrared (IR) cameras, millimeter wave radar (MMWR), LIDAR, etc.) to display features like runway obstructions and terrain in low visibility/bad weather or at night.
Synthetic Vision System (SVS)

- SVS = Synthetic Vision System (SVS uses information from a look-up database (i.e. terrain, airports/heliports) to create an artificial rendering of the outside world)
- Used today by commercial airlines, corporate General Aviation aircraft, and some rotorcraft
Combined Vision System (CVS)

- CVS: Combined Vision System (CVS combines elements of EVS and SVS imagery to create a fused image of the flight environment)
End Goals

• FAA and Industry are looking to develop operational and performance criteria for Helicopter Vision Systems Technology for enhancing safety or pursuing operational concepts for providing operational credit.

• Federal Aviation Regulations that may be informed by the results of this Research:
  – 91.176 – Amended for Helicopter Operations
  – 8260.42B – FAA Order
  – AC 90-80C – FAA Advisory Circular (Offshore Instrument Criteria)
  – 14 CFR Parts 27, 29, 43, 49, 60, 61, 67, 91, 135, 137, 141, and 145
  – AC 90-106, Enhanced Flight Vision Systems
  – AC 23-26, Synthetic Vision and Pathway Depictions on the Primary Flight Display

• Work is being performed in collaboration with USHST, EUROCAE/RTCA, VFS, HAI, and others
Questions?
Enhanced and Combined Vision Systems:
Safety and Operational Benefits for Rotorcraft Applications

Carlo Tiana - Senior Fellow - Collins Aerospace - FAA Rotorcraft Vision Systems Summit - June 25, 2021
Fixed-wing Enhanced Vision Systems Today

• Operational credit: enable visual operations (approach and land) in very low visibility; requires an Enhanced Vision System properly qualified, and a Transparent Display (91.176)

• Unlike autoland, “Visual like operation” requires:
  — minimal specific crew training
  — leverages existing ground infrastructure

• Additional benefits:
  — Night VFR terrain and surface awareness (no black hole)
Rotorwing Enhanced Vision Systems

Extend the successful Fixed-wing model

• Could go after operational credit, or reduced minima
  — Enable operations that are not possible today - as in FW case
  — Lower visibility ceilings, improved nighttime minima

• Continue to pursue “visual equivalence”
  — understood and practiced way to fly, minimal crew training
  — likely on a head-worn transparent display

• Aircraft-borne equipment
  — Does not require negotiations to upgrade ground facilities

• Night VFR is much improved over NVIS; can see LEDs
  — Could replace NVIS, with no head encumbrance

• Terrain and obstacle awareness, oil rigs, wind farms, fire fighting
Rotorwing Enhanced Vision Systems (continued)

• Compared to fixed wing systems, expectations are that:
  — Wider field of view will be required
  — Head-worn/head-mouted display likely, goggle or helmet depending on operational requirements / preferences
  — Oil and Gas, SAR, Firefighting modes provided
• Combination with Synthetic channel would improves
  — obstacle awareness
  — missions safety and success
  — system availability and assurance
Vision Systems Examples

Enhanced Vision System:
https://www.youtube.com/watch?v=xuGAxgGsqAk&t=37s

Combined Vision System:
https://www.youtube.com/watch?v=Cj_WDerrsHk&t=19s

CVS (C130) with EVS clips:
https://www.youtube.com/watch?v=0GT0Hic5zns
HONEYWELL SMARTVIEW™ SYNTHETIC VISION

Synthetic Vision for Part 23, Part 25 and Part 29

- Industry’s first Part 25 synthetic vision certification was on Gulfstream’s PlaneView flight decks in 2008

In service on business jets, regional aircraft and helicopter platforms
Synthetic Vision provides safety improvements for …

- Terrain, obstacle and runway awareness
- Stabilized approach
- Drift awareness
- Energy management

Honeywell
SYNTHETIC VISION FOR HELICOPTERS
Shown on Leonardo’s newly certified AW139 Phase 8
INTEGRATED EGPWS TERRAIN ALERTS
COMBINED VISION FOR HELICOPTER OPERATIONS

Further enhances mission success in day and night conditions in low level flight through addition of IR imagery and advanced features to the synthetic vision.

• Provide real-time awareness of information not in the database, particularly useful for offshore approaches and unimproved landing areas
• Improves speed and drift awareness during low level flight
• Contributes to a stable approach with enhanced awareness of the runway environment without a negative impact on workload by integrating where the pilot is looking (PFD)
COMBINED VISION ON LOW VISIBILITY APPROACH

Visibility: 250-1, San Luis County Regional Airport (San Luis Obispo, CA, USA)
OVER WATER OPERATIONS
Vision Systems Research

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Vision Systems Research

• Topics:
  – Visual/Vertibular Cues
  – EFVS, EVS, SVS, CVS Technologies
  – Sensor/Display Field of View
  – Pilot Performance & Human Factors Considerations of the Technologies
EHVS Research Approach

• Examine the visual references a helicopter pilot needs to acquire both with and without advanced vision systems
  – VFR: 14CFR Part 91, defined as the natural horizon, surface, and clear of clouds.
  – IFR: 14CFR Part 135, defined as existing and other references in 91.175 and 8260.42B.

• Characterize sensor performance for different sensors in various mission segments (Helicopter Air Ambulance (HAA), Offshore, Search and Rescue, etc.) and weather conditions
  – FLIR (Cooled and Uncooled)
  – MMWIR
  – LIDAR

• Examine Display Technologies and Concepts (i.e. Head-Worn Display - HWD) at various helipads (Rooftop, Offshore, Land-Based, Accident Scene, etc.)
  • Symbology
  • Heads-Up vs. Heads-Down Time
  • Information Display (What is Important?)
FAA’s S76-D Simulator

- Integrated with FAA’s WJHTC Simulation Labs
- Paired with Aviation Weather/Navigation Apps (i.e. Foreflight, etc.)
- Tailorable for various Weather Conditions
- Displays are configurable
- Eye-trackers/cameras
- HWD/HMD Integration
- SVS Integration
- EVS/CVS Integration Possible
FAA Experimental Helipad (HPM77)
Initial Findings – Sensors

- Deck Angle
- Field of View (FOV)
- Shadows
- Obstructions
- Thermal Crossover
- Precipitation/Moisture
- Sensor Resolution
- Direct Sunlight
Initial Findings – Displays

• Glare
• Ambient Lighting
• Display Aspect Ratio
• Symbology
• Ergonomics/Eye Fatigue
• Conformance
Future Work

• Vision Systems Summit
• Literature & Product Technology Reviews – Update
• Simulator Trials
  – FAA WJHTC S76 Simulator
• Flight Trials
  – Iowa University Operator Performance Laboratory (OPL) & USAF Test Pilot School
  – Demonstration Efforts with European Operators, Helicopter OEM’s, and Vision Systems Manufacturers
  – FAA WJHTC Flight Trials
  – Lifeflight of Maine Flight Trials (as part of IFR Infrastructure Project)
Questions?
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