Vision Systems Research

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Helicopter Enhanced Flight Vision Systems (H-EFVS)

Research Purpose: Investigate Helicopter Vision Systems technologies to determine if they can improve the safety of flight and could provide operational credit/benefit for certain rotorcraft operations.
Vision Systems Components Terminology

- HUD = Heads-up-display
- HWD = Head-worn-display
- HMD = Head-mounted-display
- 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)

Sensor & Computer + Display = H-EFVS

(FLIR, MMWIR, LIDAR, etc.)
(HWD, HMD, HUD, HDD, etc.)
End Goals

- FAA is 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
The ability of the sensor to provide a visual advantage may allow operations in visibilities where operations might not be permitted using natural vision.
Relationship to Regulators, Standards Groups, Safety Organizations

• EUROCAE WG-79/RTCA-SC213
• United States Helicopter Safety Team (USHST)
  – Helicopter Safety Enhancement #91 – Vision Systems Technologies
  – Helicopter Safety Enhancement #127A – Spatial Disorientation
• International Helicopter Safety Foundation
  – Helicopter Safety Technology Survey
• FAA, EASA, Other Regulators/Civil Aviation Authorities
“FAA and industry to research, develop, and promote the use of enhanced helicopter vision systems (EHVS) technologies (e.g. Night Vision Goggles, Enhanced Vision Systems, Synthetic Vision Systems, Combined Vision Systems, etc.) to assist in recognizing and preventing unplanned flight into degraded visibility conditions due to weather and to increase safety during planned flight at night.”
USHST H-SE #91 Team Members

Collins Aerospace
Honeywell
L3HARRIS
Georgia Institute of Technology
Emory-Riddle

Aviation Analysis Experts
Critical Care Transport and Training

FEDERAL AVIATION ADMINISTRATION
SIKORSKY
A LOCKHEED MARTIN COMPANY

Pfizer

ARIZONA
EUROCAE WG-79/SG-4 Combined Vision Systems

• Working Group 79/Subgroup 4
  – Meets every two weeks
  – Composed of SME’s from Vision Systems Technology Industry Manufacturers, Helicopter OEM’s, and Government Agencies (i.e. FAA/EASA)
  – CVS MASPS Document (In Progress to be completed before the end of the calendar year)
  – Holding Joint Industry Vision Systems One-Day Summit with USHST H-SE#91 in Spring 2021
Vision Systems Summit

• Who?: Comprised of Operators, Regulators, Device Manufacturers, Helicopter OEM’s, etc.

• What/When?: One-Day Event in Spring 2021 (Date TBD)

• Where?: Virtual

• Why?: “To Solicit feedback on operational concepts and generate agreement on path forward to advance the proliferation of these devices on rotorcraft for enhancing safety and operational efficiency”
Guided Discussions Recap

• Held Guided Discussions with:
  – 15 individual operators
  – 5 industry associations
  – 3 industry special instrument approach procedure design firms

• Results (Captured in an Internal FAA Report)
  – Big Driver for Safety
  – No Particular Individual Operational Driver for Operational Credit (but did identify the following operational candidates):
    • Point in Space (PIInS) Onshore Approaches
    • Offshore Approaches
    • Runway Instrument GPS Approaches with visibility limitations
    • VFR/IFR En Route/Departure Operations in a fjord/canyon valley/ridgeline, etc.
    • Relief from Alternate Requirements
Statistics on Instrument Approach Procedures and Airports

- Airport
- Approach Type
- Runway number
- Normal CAT Visibility (sm)
- Helicopter Visibility (sm)
- Limitations on Helicopter Visibility Reduction
- Limitations on Night Visibility
- Class of Airspace
- Towered Airports
Total number of Maine IAPs: 96
Observations: Most of Maine IAPs have limited reductions on helicopter visibility minima
Most of the RNAV and VOR approaches have limited reductions on helicopter visibility minima.
Total number of Maine IAPs: 96
Observations: Most of Maine IAPs have night visibility limits (e.g. procedure NA at night)
Most of the RNAV and VOR approaches have night visibility limits
Total number of Maine IAPs: 96
Observations: Most of Maine airports are class of airspace G

Maine Airports
Class of Airspace of the Destination Airport

Class of Airspace

- **G** (58.8%)
- **E** (20.8%)
- **C** (10.4%)
Total number of Maine IAPs: 96
Observations: Most of Maine airports are not towered
Most of the RNAV approaches are done in not towered airports
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
- Remote Monitoring of Simulation Sessions via Zoom
- HWD/HMD Integration – In Progress
- SVS Integration – In Progress
- EVS/CVS Integration – In Progress
FAA Experimental Helipad (HPM77)
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?)
Heliport/Helipad Diagram

Note: Layout diagrams should be drawn to scale with key dimensions shown such as TLOF size, FATO size, Safety Area size, distances from safety area perimeter to property edges, etc.
Heliport Approach Lighting System (HALS) or Lead-In Lights

NOTE: The depicted HALS system is appropriate for a heliport located at an elevation up to 1,000 feet (305 m) above mean sea level.

NOTE: The depicted HiLS system has elevated FATO edge lights. Flush FATO edge lights are also an option. Flush FATO edge lights would be placed just inside the paragraph 210d(1) and 310c(1).

Figure 7-2. HALS Lighting System: PRECISION
Heliport Instrument Lighting System (HILS)

6-1. Heliport Instrument Lighting System (HILS):
NONPRECISION

NOTE: The depicted HILS installation is appropriate to a minimally sized heliport located at an elevation up to 1,000 ft (305 m) above mean sea level.
EHVS Experimental Trial
EHVS Experimental Trial

Experimental Conditions:
- FATO/TLOF Lights On
- Night
- EVS
- HWD (worn by Pilot Flying)

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Video Clips: Helipad Approaches – Fog and Night

(Click to play)
HDD During Flight In Fog Symbology + EVS (voxels)

(Click to play)
HMD During Night Approach To Helipad Symbology + EVS (voxels) + SVS (DTED)
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?