HELI CLEARVISION™ A REVOLUTIONARY ONBOARD ENHANCED FLIGHT VISION SYSTEM

O.Riberon
Elbit Systems (France)

OVERVIEW

This paper presents the functionalities and architecture of a revolutionary onboard Enhanced Flight Vision System for civil aviation rotorcrafts. Today flying in poor weather conditions represents challenges and risks for most of the operators who desire to achieve higher mission completion rate. Lack of Situational Awareness and Degraded visual environment conditions are the accident top root causes for helicopters.

The system has been designed to support flying Head Up with combined flight symbology, enhanced and synthetic vision. The display combines real-time imagery from various visual sources with 3D vision, obstacle detection and terrain avoidance systems, as a result it improves flight safety and situational awareness, increases mission success rates and minimizes the dependency or risk of spatial disorientation. The system also creates a roadmap to reduce landing minima in IFR procedures for oil and gas, mountain rescue, medical transport missions and police.

The system is in advanced stages of development and certification for commercial aviation customers.

The system is composed of a head wearable display, head tracking system, multi-spectral camera, & computer and addresses both non-helmet and helmet users. Associated applications, such as EVS, SVS or CVS, offer helicopter pilots a “real-world” view of the terrain along with all obstacles within their flight path, allowing them to “see and avoid” even when visibility outside the aircraft is limited.

User benefits are numerous during all phases of flight such as always providing a realistic perception of relief or position of the helicopter and clearly see the landing area and obstacles during maneuvers close to the ground.

1. CHALLENGES

Flying in poor weather conditions is a daily challenge for all Helicopter operators. The high risk of accident induced by the presence of clouds and fog, when the helicopter flies VFR in areas with a lot of vertical obstacles like towers, mountains is obvious. These flights generate a high workload to the pilot and can increase his disorientation, up to losing control of the Helicopter. In these conditions, there is no visibility of landing area or obstacle. The pilot is unable to see though smoke, dust or snow and by coming close to the ground, he suffers the phenomena of brownout. Flying low altitude over water in these low-visibility situations or during night has the risk of bad perception of relief or of bad position of helicopter and can lead to catastrophic results.

Most of the helicopter missions require visual meteorological conditions (VMC), and the pressure of mission completion can force the

pilots to take too many risks especially with the combination of the lower minima.

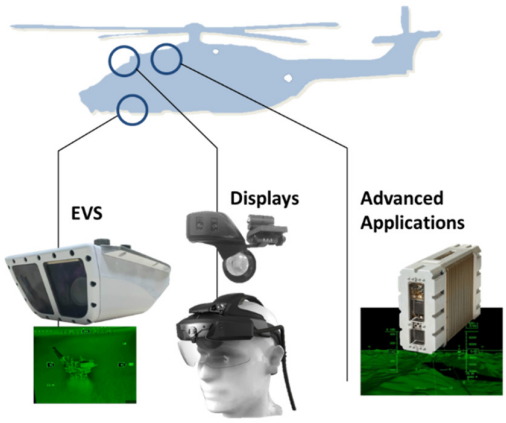
2. DESCRIPTION OF THE HELI CLEARVISION™ SYSTEM

In order to acquire the information, process it and then display it to the pilot, the Heli ClearVision™ system is composed of three main hardware elements:

- A Multi-spectral lightweight sensor (HeliEVS™) to acquire the information.
- A Computer Unit (CU) to process this information.
- A display element to visualize this information. It can be a proven day and night HMD (SkyVis™) with commercially certifiable line-of-sight (LOS) technology for helmet users, or an innovative head wearable display (Skylens™) for non-helmet users.

Associated to the hardware, several software applications are provided in order to fulfill the needs of the various users, missions and platforms. Among others, the main ones are:

- Enhanced piloting symbology such as: Guidance, Low Visibility Landing (LVL)
- Enhanced Awareness Applications such as Synthetic Vision System (SVS), Helicopter Terrain Awareness and Warning System (HTAWS) and Combined Vision System (CVS)



Heli Clearvision™ elements

This solution based on a long experience in certified EFVS products for commercial airplanes, is designed for certification according to civil standards and is in line with FAA/EASA current and upcoming regulations. The system can be configured both in terms of hardware and software to perfectly cope with the user requirements.

Each of the elements of the system is described in more details in the following paragraphs.

1.1. SkyVis™

As an add-on to the pilot's own helmet, SkyVis™ is easily integrated with minimal footprint in the cockpit. The pilot is able to fly "eyes out" due to the wide field of regard. One of the system's unique advantages is its head tracking capability which assists in preventing disorientation during low visibility maneuvers in any field of regard. The head tracking system is a dual redundant hybrid technology suitable for the commercial aviation word. The innovative optical tracker is a combination tracking technologies which avoids the need for a large target array (in the cockpit or on the helmet), reduces sensitivity to Helmet or cockpit deformations and provides very high accuracy

SkyVis™ has both day and night displays mounted on the TSO-C164 certified NVG.

1.2. SKYLENS™

Skylens™ display is a lightweight unit utilizing a high transparency visor as the element that combines external scenery with internally generated image. It uses the same display module as SkyVis™ and provides display with similar characteristics to SkyVis™ such as Field of View (FOV) or Angular resolution.

The Skylens™ is based on knowhow and technologies collected in over 30 years' experience with Head Mounted Displays, and has already completed hundreds of hours of flight tests on multiple aircrafts and helicopters

Skylens™

All the technologies of the Skylens™ are mature, proven and qualified to airborne environment.

The baseline technology building blocks for the Skylens™ including the tracker components and display source are already qualified and in series production.

1.3. HeliEVS™

Based on the ClearVision™ EVS for fix wing application, HeliEVS™ offers a high quality sensitive video image in 35° x 27° FOV and is packaged in a single Line Replaceable Unit (LRU) sealed with an optical window with integral heater to avoid icing and condensation. It autonomously performs the complete Enhanced Vision System capability. This optimized multispectral sensor enables improved situational awareness and provides the benefit of operational credit.

The processing is performed in electronics hardware to minimize latency. Functionality is accomplished through real-time image fusion between multiple sensors at multiple spectral bands. The spectral bands were selected based on multi-year studies of the properties of light penetration through poor weather conditions thus providing day and night best signal to noise ratio at most weather conditions such as fog and low-visibility. These spectral bands are the Visible NIR (Near Infra-Red) and LWIR (Long Wave Infra-Red) achieving maximum situational awareness.

1.4. Computer Unit

The Computer Unit (CU) architecture is based on of the shelf building blocks, certified to DO-254 (DAL A) standard for Complex Electronic Hardware (CEH) according to Design Assurance Level derived from the system safety analysis. Its main Operational Flight Program (OFP) and monitor processors are based on existing qualified and certified to DAL A elements.

The Computer Unit receives flight information via full dual redundant ARINC 429 channels, the data being processed to relevant display files which are then translated to symbols by the ESL certified OpenGL Hardware accelerator. It can drive up to 1280x1024 8bit display refreshing at up to 60 Hz.

1.5. Applications

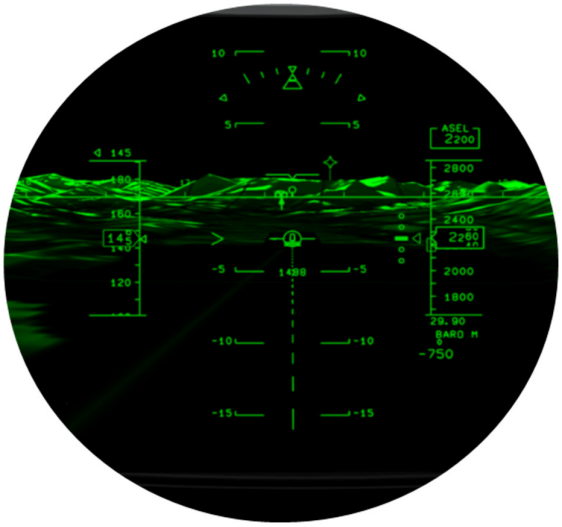
1.1.1.Symbology

Symbology is conformal, highly configurable depending on flight phases and provides two

and three dimensional symbols. The display is divided into flight phases with the necessary symbology for each of them such as Take-Off, Flight (climb, cruise and descent) and Approach. As an example, the speed and altitude scales can be removed during flight using the declutter mechanism, allowing the display to be less crowded. Displaying PFD conformal data allow pilots to fly eyes out while keeping the highest level of safety

1.1.2.SVS

The SVS main intended functions are to provide Situational awareness at all phases of flight (Providing displayed data of terrain, obstacles, airports information and flight plan).



SVS & Symbology

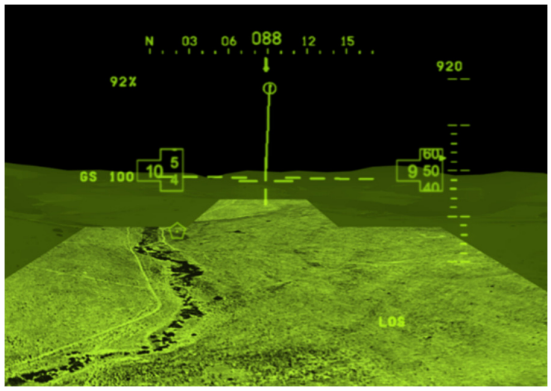
SVS is based on a standardized database of runways, obstacles, terrain, and flight plan information (managed under DO-200A). The information is displayed as an underlay in the pilot's primary flight display (PFD) and complies with RTCA/DO-315B

1.1.3.CVS

The CVS combines a conformal flight guidance symbology with the high-resolution image of the real world and the synthetic vision. The image comes from the HeliEVS™ multi-spectral sensor

The result is displayed on SkyVis™ or Skylens™. It allows the flight crew to use the benefits of both capabilities.

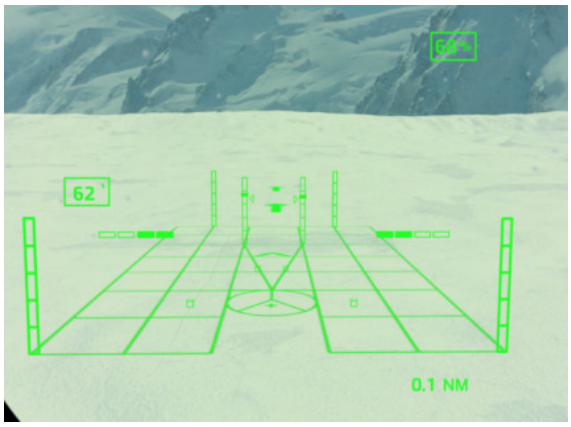
The CVS is used for situational awareness at all phases of flight.



CVS

1.1.4.LVL

To better coordinate situational awareness in a two-pilot cockpit, an enhanced symbology powered by the LVL system is provided.



LVL

By presenting a "synthetic world map" based on a 3-D map, representing the real world, the LVL system has been designed to provide symbology to the pilot. It allows him to maintain spatial orientation and awareness during relevant phases of the flight, day and

night, both Good Visual Conditions (GVE), and especially under Degraded Visual Environment (DVE) conditions, during landing and take-off caused by whiteout or brownout.

Since the approach for landing is very important for safe DVE landing, the Landing symbology set provides dedicate approach cues guiding the pilots to a Landing Point (LP) in a controlled path (Glide slope and velocity)

1.1.5.HTAWS

Clear Flight into Terrain (CFIT) accidents prevention is achieved by providing visual and aural means for warning the pilot from excessive vertical closure or closure rate into terrain and immanent foreseen conflict with terrain or obstacle.

ESL Terrain Warning System conforms to the following civil helicopter standards TSO-C194 (DO-309) and AC29-MG18:

Following the standards, Terrain Warning System includes:

- GPWS - Ground Proximity Warning System visual and aural alerts
- FLTA - Foreword Looking Terrain Avoidance visual and aural alerts
- Low sensitivity mode for low level VFR flight
- Off airport mode for landing at uncharted landing zones

The combination of SVS and TAWS can be beneficial by presenting the predicted “hit point” on the synthetic ground image

3. USER BENEFITS

User benefits are numerous and increase both situational awareness and mission completion rate.

The system reduces the pilot’s head and eye motion during cockpit scanning, thereby increasing in-air safety levels disorientation during low visibility maneuvers.

With such a system, the pilot is able to fly “head out” due to the wide field of regard display, relying on the data displayed in front of his/her eyes. The system assists during maneuvers close to the ground and in limited visibility conditions such as transition from Instrument Flight Rules to Visual Flight Rules without the need to look inside the cockpit The system will also allow “extended VFR” where the pilot can fly under VFR conditions with reduced visibility ranges.

In addition, increased navigation capabilities are achieved by displaying obstacles, traffic, waypoint, and any navigation and aeronautical data as well as flight path markers, in correlation with real-world terrain, assisting to a reduced workload for the pilot.

4. CONCLUSION

Flying with Heli ClearVision™ is entering a new world of enhanced situational awareness, extended operational flexibility and mission efficiency. It reduces pilot workload, while providing him any information he needs at the right time and at the right place. It allows him to take the right decision during take-off, approach and landing. It is the clearest path for a safe arrival.

*) The Heli ClearVision™, HeliEVS™, SkyVis™ and Skylens™ logos and names appearing herein are the trademarks of Elbit Systems Ltd. and its affiliated companies.