

DEVELOPMENT OF INTEGRATED AVIONICS FUNCTIONS FOR EXTERNAL SITUATION AWARENESS IN CIVIL HELICOPTER MISSIONS

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Abstract

Providing a consistent perception about the external situation to the helicopter flight crew can greatly enhance awareness, simplify mission and contribute to a safer operating environment. This paper focuses on the HELIONIX® external situation awareness functions including SVS, HTAWS, DMAP integrated in the HELIONIX® avionics suite of Airbus light and medium helicopter platforms. First, a background of CFIT incidents that motivated the development of the external awareness functions is presented. The context of civil helicopter mission is then described to identify the needs regarding external awareness under different operations. Thereafter the main capabilities of the SVS, HTAWS and DMAP functions along with their HMI concept are explained. Finally, some aspects about a standardised common development and certification approach are highlighted. Due to the awareness functions being fully embedded in the cockpit multi-function displays, a coherent and consistent HMI concept as well as cost, weight and space savings are achieved while answering the needs of civilian helicopter missions.

1. ABBREVIATIONS

(E)GPWS	(Enhanced) Ground Proximity Warning System
ACAS	Airborne Collision Avoidance System
AIRAC	Aeronautical Information Regulation And Control
CFIT	Controlled Flight Into Terrain
DMAP	Digital Map
DTED	Digital Terrain Elevation Data
EASA	European Aviation Safety Agency
FAA	Federal Aviation Administration
FLTA	Forward Looking Terrain Avoidance
FND	Flight and Navigation Display
FPV	Flight Path Vector
HEMS	Helicopter Emergency Medical Services
HTAWS	Helicopter Terrain Awareness And Warning System
IFR	Instrument Flight Rules
MFD	Multi-Function Display
NAVD	Navigation Display
SVS	Synthetic Vision System
TCAS	Traffic Collision Avoidance System
VFR	Visual Flight Rules

2. INTRODUCTION

Helicopters are pressed into missions where they have to fly at low altitude, often in uncontrolled airspace and mostly in VFR. Environmental factors such as weather, terrain, obstacles as well as surrounding air traffic have an impact on the conduct of the mission and consequently on flight safety. The European Helicopter Safety Team (EHEST) constituted a body of experts to analyse European rotorcraft accidents between 2000 and 2010. The study concluded that about 70% of the accidents had pilot judgment as a contributing factor while about 35% of the accidents had pilot situation awareness as a contributing factor [EHEST2015]. The nature of helicopter missions exposes them to greater risks. As helicopters tend to operate mostly under visual flight rules at low altitudes – and thus being in close vicinity to potential obstacles – partly explains the relatively poor safety record of helicopters compared to commercial fixed wing aircraft.

Based on the analysis of accidents, EHEST defined a technology matrix to analyse the potential of technologies to mitigate accident-causing factors. The 15 technologies ranked 'highly promising' include the Enhanced Ground Proximity Warning System (EGPWS) and the Digital Map (DMAP) with elevation and obstacle information [EHEST2014]. These technologies need to be usable and affordable to gain acceptance for widespread use.

External references used in VFR missions include obstacles, terrain topology, aeronautical infrastructure such as airports, heliports, aids to navigation and cultural data such as roads and railways. Major information is also air traffic in the vicinity of the aircraft. In VFR flight, the pilot has the responsibility to see and avoid potential threats such as terrain, obstacles and air traffic. Providing a mean to help the pilot detect external references and correlate them with current aircraft location with visual and auditory cues increases the level of awareness. Thus, enhanced external situation awareness functions, when properly designed, have the potential to mitigate at least some factors that may lead the helicopter into potentially unsafe conditions.

The need of the hour is to provide mature and cost effective functions for enhanced external situation awareness. Airbus Helicopters has designed and certified external awareness functions integrated within the state-of-the-art HELIONIX® avionics suite. The key highlights of HELIONIX® are an integrated avionics system and common solution deployment to maximize reuse in line with the Airbus' "family concept". The HELIONIX® installation is currently certified on Airbus' medium and light-twin helicopter platforms. The HELIONIX® suite boasts of many novel features and innovations from piloting and mission perspective which have been aptly described in previous publications [Guillant2011, Ockier2015]. While ease of piloting is an essential aspect, the ability to provide coherent and correlated information regarding the external situation and mission eases the performance of the mission. This paper focuses on the innovative technical features of the HELIONIX® functions of Helicopter Terrain Awareness and Warning (HTAWS), Synthetic Vision System (SVS) and Digital Map (DMAP).

3. CONTROLLED FLIGHT INTO TERRAIN

Controlled flight into terrain (CFIT) happens when an aircraft under crew control unintentionally collides with surrounding terrain and obstacles. This undesirable event occurs due to lack of sufficient awareness on the part of the crew in terms of the proximity to terrain and obstacles. The International Helicopter Safety Team (IHST) studies indicate that CFIT is the 13th most common type of accident. Furthermore 60% of all CFIT accidents are fatal [IHST]. CFIT accidents mostly occur in low visibility scenarios and in mountainous terrain. However it does not exclude CFIT accidents in VMC conditions. Better awareness about terrain and obstacle proximity along the helicopter's flight path can potentially mitigate the risk of CFIT accidents.

The development of the ground proximity warning system (GPWS) is traced to the fixed wing environment. Due to a number of CFIT accidents, the US Congress mandated in 1975 to install GPWS in transport aircraft. Early GPWS systems operated on barometric altitude and radio altimeter reading to compute height above ground and rate of descent. When these parameters were violated according to predefined limits, pilots were given visual and audio warnings. GPWS systems were advisory in nature and the pilot had to manually take corrective action. Later statistics indicated a drop in CFIT accidents in transport aircraft, from 35 per year in 1975 to 6 in 1995 [Breen1999]. Thus GPWS together with several other technical advances have contributed to improve the safety of fixed wing aircraft. One of the limitations of GPWS is that the radio altimeter senses ground proximity vertically downwards but not in the forward direction. This is remedied by the enhanced GPWS (EGPWS) that used a combination of the flight path vector and digital terrain elevation data (DTED). Relative elevation information overlaid with man-made obstacle data provides a forward looking awareness used to warn flight crew in advance of potential conflicts. The addition of relative elevation information also provides awareness about the absolute terrain topology and relative proximity to terrain in the area of interest.

The development of EGPWS on helicopters (or equivalently HTAWS) is complicated by the fact

that helicopters operate in VFR and are known to intentionally manoeuvre at low altitudes. Depending on the type of mission, helicopters may fly close to known obstacles and terrain. The HTAWS function relying on vertically looking and forward looking measurements therefore needs to be tailored to the helicopter mission needs to avoid the so-called “nuisance alerts” without an overly complex alerting envelope. Another important aspect is the quality and resolution of terrain and obstacle data upon which the alerts are based. Poor resolution data does not accurately reflect terrain topology especially in mountainous areas. However high resolution data requires larger memory and performance needs. Therefore the challenge lies in striking a balance between providing the necessary alerting envelope, reducing nuisance alerts and optimizing hardware and software performances.

4. MISSION ANALYSIS

Operators of helicopter platforms of Airbus perform a wide palette of specific and generic missions. An important aspect for successful conduct of the mission is the depiction of the external references. It allows a correlation between the aircraft’s current dynamic situation with the elements external to the aircraft. To determine the needs for external awareness it is necessary to understand the context in which missions are performed. This approach also eases validation of the requirements and design.

4.1. Offshore Operation

Offshore missions involve maintenance and service of platforms at sea. The platforms are typically oil rigs, wind farms and crew transfer vessels. The needs of the mission are to transport personnel and loads from onshore to the offshore location. As platforms can be located deep into the sea, helicopters may also be pressed into medical evacuation and rescue in the event of disasters. In locations where personnel have to be deployed without a landing facility such as on offshore wind parks, the helicopter has to winch personnel to and from the platform. Since weather at sea is unpredictable and may change rapidly, it is important to be aware of the geo-locations of the waypoints, platforms and landmarks. Furthermore, awareness about surrounding air traffic, vessel traffic, weather conditions and obstacles on sea is needed in the mission.

Recently, special HTAWS alerting envelopes for offshore operations have been proposed by the UK CAA to improve warning times for offshore operations without incurring an undue number of nuisance alerts [CAA2017].

The offshore mission may be performed under VFR or IFR. In IFR, dedicated routes need to be established together with IFR capable avionics installation. In VFR flight the aircraft may be flown with the help of visual reporting points and by visual avoidance of aircraft and obstacles. Therefore providing such information that eases correlation of the external situation simplifies the mission tasks.

4.2. HEMS Operation

The HEMS mission involves evacuation and rescue of injured persons from an accident site to an appropriate medical centre. The helicopter is often pressed into service when time is a critical factor or if the accident site is inaccessible by ground vehicles such as in mountainous terrain. A secondary operation under this umbrella also includes hospital to hospital transfer of patients and organs.

Due to the nature of this mission, preparation time is often short and the helicopter may be pressed into service at any point in time (day, night). As most HEMS missions are flown under VFR, accepting or rejecting the mission depends on the prevailing weather conditions. Furthermore the helicopter may be required to land in unprepared areas in the vicinity of the accident site. If a landing spot is unsuitable then medical personnel and survivors need to be winched into the helicopter.

Thus, awareness of terrain contours and obstacles in correlation to the helicopter’s own position and altitude provides important awareness. Cultural data such as roads, railroads, populated areas, water bodies depicted in the cockpit and observed with eyes out provides support to the intended route to the next location. From a regulation perspective, the FAA mandate effective from 2018 requires all HEMS operators in the US to equip aircraft with HTAWS and radio altimeters. The HTAWS mandate by EASA applies from January 2019.

4.3. VIP & Corporate

Corporate missions involve transporting personnel and VIPs from point to point. In this mission, comfort, speed and endurance are important factors. Missions are typically pre-planned based on locations, estimated weather conditions, major landmarks and typically flown in VFR. The external situation awareness needs include surrounding traffic, terrain, obstacles and aeronautical waypoints. Cultural data such as roads, railroads, populated areas, water bodies are often used as landmarks in the mission. Therefore correlation of the helicopter location with cultural data is important.

4.4. Public Services & Parapublic Operations

Missions performed in the frame of public services can be quite diverse. They include airborne surveillance of the ground and maritime situation, airborne pursuits by law enforcement agencies, special operations, surveillance of land and maritime borders, search and rescue operations on land or at sea. Due to this variety, the needs on situation awareness are highly dependent on the mission. Essential awareness of the traffic, terrain, obstacles landmarks, waypoints and cultural data are sufficient in lighter missions. More demanding missions require specialized sensors and equipment.

4.5. Summary of Needs

The commonly identified needs regarding external and ground references can be summarized as follows:

- Absolute and relative proximity to natural and man-made features in near-term and long-term;
- Relative information about cultural elements in near-term and long-term;
- Essential and complementary information about aeronautical elements surrounding the flight route;
- Presence of other air traffic and weather in near-term and long-term;
- All static or dynamic elements (e.g. marine traffic, waypoints, target locations) that may affect the conduct of the mission.

5. EXTERNAL SITUATION AWARENESS FUNCTIONS INTEGRATED IN HELIONIX®

The essential premise of HELIONIX® is to achieve a family concept for standardization as well as cost-effective state-of-the-art solutions for the helicopter platforms. The challenge for situation awareness is to ensure a high level of generalization covering a wide range of missions, and at the same time to provide effective awareness where required. The additional benefit of the HELIONIX® awareness functions is that the software applications are hosted on the HELIONIX® Multi-Function Displays (MFD), which optimises cost, weight and space in the cockpit.

5.1. Synthetic Vision System (SVS)

The Synthetic Vision System (SVS) provides a 3D representation of the helicopter external environment on any of the HELIONIX® Multi-Function Displays (MFD). The SVS includes a 3D synthetic depiction of the following elements intended to enhance the correlation of the flight trajectory with external references:

- Natural elements including terrain and water bodies
- Man-made elements including obstacles
- Aeronautical points including runways and helipads
- Cultural elements including roads and railroads

The sky is depicted above the artificial horizon. All the SVS elements (terrain, obstacles, aeronautical or cultural) are based on certified databases pre-loaded inside the HELIONIX® MFDs. The SVS is a clear and intuitive tool for the flight crew to anticipate the presence of terrain or obstacles, when the horizontal distance of visibility is less than the SVS range and to support the pilots to find external natural or man-made visual references. The SVS assists to locate the aircraft position with reference to aeronautical waypoints during en-route or during approach phases. When flying closer to ground, the SVS provides a coarse sense of helicopter's altitude above ground, the proximity to the terrain and relative movements.

The SVS image is presented in the background of the flight navigation information as shown in

Figure 1 including, among others, the helicopter attitudes, the horizon line and the flight path vector (FPV). These primary flight data are conformal with the SVS image. The FPV indicates the instantaneous direction of the helicopter. When correlated to the SVS image and elevations or obstacles, it can highlight potential future conflicts to terrain or obstacles to the pilot. Aeronautical elements in the form of runways and helipads are depicted along with a label for the appropriate ICAO identifier.



Figure 1: SVS image behind primary flight information

When a runway or heliport is part of the flight plan, then the SVS provides colouring of the selected runway or heliport. The SVS usage is not limited in terms of helicopter missions or flight conditions. Although its main usage and interest is for VFR flights including those with reduced visibility conditions, nevertheless, in IFR flights too, SVS also provides awareness to correlate the conduct of flight with respect to the surrounding environment. The depictions of man-made cultural features (roads, railroads) or aeronautical infrastructure (runways) provide assistance in the mission even over relatively flat terrains.

5.2. Helicopter Terrain Awareness and Warning System (HTAWS)

The HTAWS function is intended to provide active proximity awareness to obstacles and terrain in order to reduce the likelihood of controlled flight into terrain or obstacles. HTAWS provides aural

and visual alerts when terrain and/or obstacles represent a hazard with respect to the helicopters anticipated flight trajectory. HELIONIX® HTAWS is a Class A system and meets terrain alerting and ground proximity requirements in accordance with TSO-C151b (including certified TSO-C194 algorithms) and Minimum Operational Performance Standards (MOPS) in accordance with RTCA DO-309. HTAWS provides the flight crew with alerts generated from two simultaneous alerting mechanisms:

- Ground Proximity Warning System (GPWS)
- Forward Looking Terrain Avoidance (FLTA)

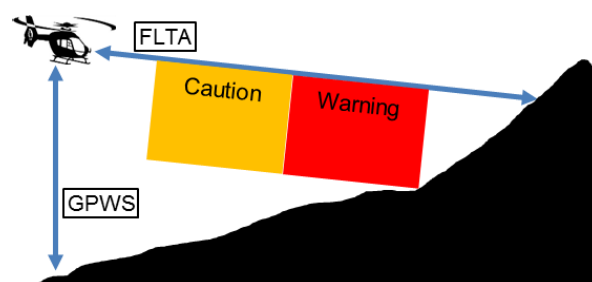


Figure 2: HTAWS FLTA and GPWS illustration

Figure 2 illustrates the two HTAWS mechanisms. GPWS applies the classical vertically downward proximity warning based on radio altimeter readings whereas FLTA is the forward looking awareness on the basis of the flight path vector. While GPWS is based on the classical modes, the FLTA provides an amber zone and red zone depending on the estimated time to collision. The amber zone triggers a caution alert whereas the red zone triggers a warning alert.

The GPWS function provides alerts in case of potential vertical collision of the helicopter with the terrain. The following GPWS modes have been designed on the HELIONIX® HTAWS:

- GPWS Mode 1: Excessive descent rate providing warning & caution alerts. This mode is active for helicopter altitude below 1,500 feet.
- GPWS Mode 3: Excessive altitude loss after take-off. This mode provides a caution alert if the helicopter loses more than 40% of its accumulated altitude after take-off.
- GPWS Mode 4: Insufficient terrain clearance based on radio altimeter, indicated airspeed and landing gear status;

- **GPWS Mode 5:** Excessive downward deviation from ILS glideslope or LPV glideslope providing caution alerts;
- **GPWS Mode 6:** Altitude callouts to avoid inadvertent drifting down

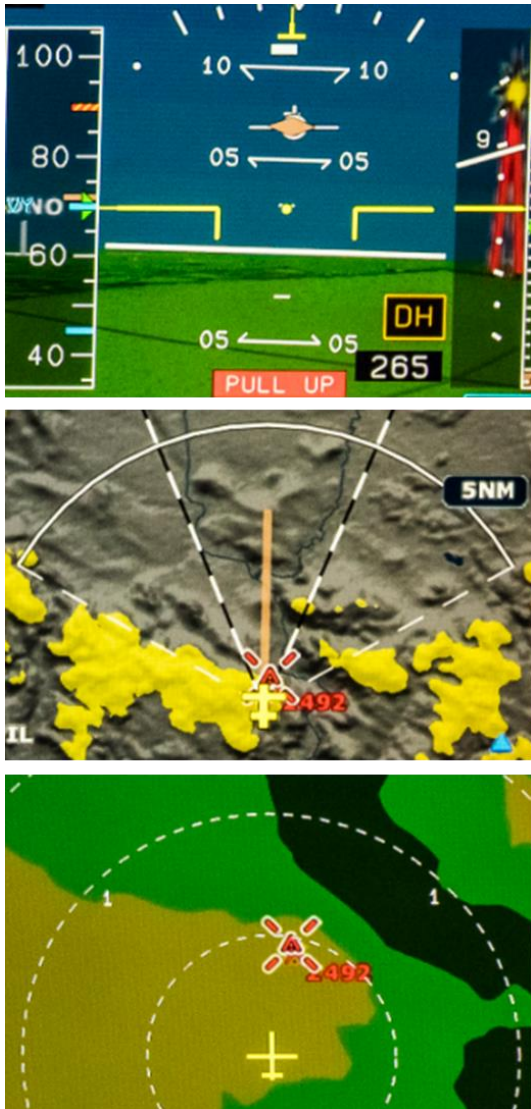


Figure 3: HTAWS Alerts on Primary (top), DMAP (mid) and Navigation (bottom) formats

The FLTA functionality displays warnings and caution alerts in order to increase awareness of proximity to and avoid collision with terrain or obstacles. FLTA alerts depend on terrain and obstacles elevation. Alerts are computed using a DTED database with obstacles compared to the helicopter height, position and ground speed. In order to maximize the effectiveness the FLTA alerting envelope behaviour is adjusted in accordance with the flight trajectory in terms of direction (level flight, climb, descend and ground

speed). However nuisance alerts are undesirable and disturbing because they represent no apparent threat for the intended manoeuvre. Excessive nuisance alerts may lead the crew to ignore the alerts or turn off the HTAWS function. The FLTA logic is therefore optimized to reduce and eventually eliminate nuisance alerts.

The aural alerts are provided via the helicopter audio system and the visual alerts are displayed on the main cockpit display formats as shown in Figure 3. Amber and red labels for caution and warning alerts respectively are displayed on the primary flight display, navigation display and DMAP format. The location of the alert with respect to the helicopter own position is depicted with a dedicated symbol on the display formats.

Finally, the HELIONIX® HTAWS will continue to develop and offer functions in response to specific needs such as improved GPWS modes for offshore operations as recommended by the UK CAA in [CAA2017]. This will include the offshore envelopes 1, 3 and 4 to replace the classical modes 1, 3 and 4 respectively. The offshore envelope 7 which will provide protection against loss of airspeed on approach will also be treated within HELIONIX® together with the control of onshore and offshore modes.

5.3. Digital Map (DMAP)

The DMAP function is intended to increase situation awareness of the flight crew by providing a correlation between geographic, hypsometric, navigational and mission data in a single display format. DMAP provides visualization of 2D maps including terrain elevation, ground vector and raster maps. HTAWS overlay is provided in the form of terrain colouration according to height above terrain (HAT) as shown in Figure 5 where red represents terrain above current helicopter altitude and amber represents terrain up to 250 ft. below current helicopter altitude. It provides awareness about the current flight situation with respect to the surrounding terrain which is particularly useful in low altitude operations. Terrain or obstacle conflict symbols calculated by HTAWS are presented on the DMAP to provide an immediate view with regards to the direction and location of the conflict. Particular care is taken to remove display of obstacles and alerts when

the DMAP not in heading up orientation as it may lead to confusion with regards to the actual direction of threat. The overlay of flight plan on the moving map as well as underlay of a map background in the navigation display (NAVD) format assist the crew in correlating navigational and geographic information. Awareness regarding surrounding traffic is visualized over the geographic and navigational information if an appropriate transceiver (TCAS I or II) is installed and configured. The track line assists to recognize the direction of flight on the map and identify terrain, obstacles, cultural and aeronautical elements relevant for the next phase of the flight. Using data about remaining fuel quantity, airspeed and wind conditions, the DMAP also provides a very coarse view of the achievable fuel range on ground, of course disregarding manoeuvres and altitude changes. Some of these elements are illustrated in Figure 4. Owing to the integrated modular avionics features, the DMAP format can be visualized on any of the helicopter's Multi-Function Displays (MFD) except on the pilot's primary flight display.

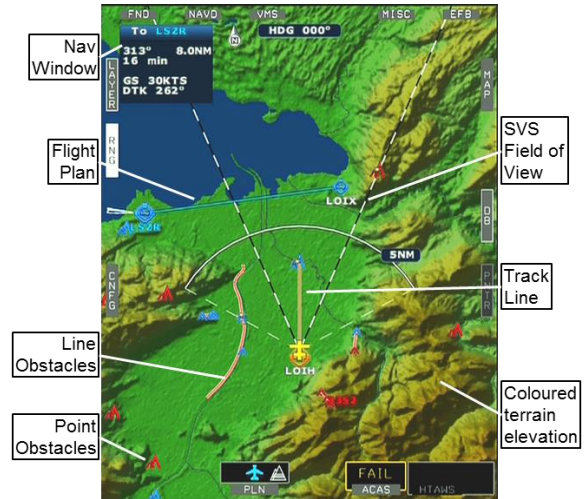


Figure 4: DMAP format

To avoid cluttering the display area with excessive information, the data to be displayed are organised according to the relative importance and data types. As shown in Figure 6, the bottommost layer is the base map consisting of absolute elevation, vector or raster maps. Subsequent layers consist of aeronautical, obstacles and flight plan information. The uppermost layer consists of the TCAS intruders and HTAWS alerts since they may require immediate attention or possibly an action by flight crew. Furthermore, the use of soft keys to clutter and declutter individual data overlays as well as grouping of similar data types ensures that readability is maintained in operational areas with high density information.

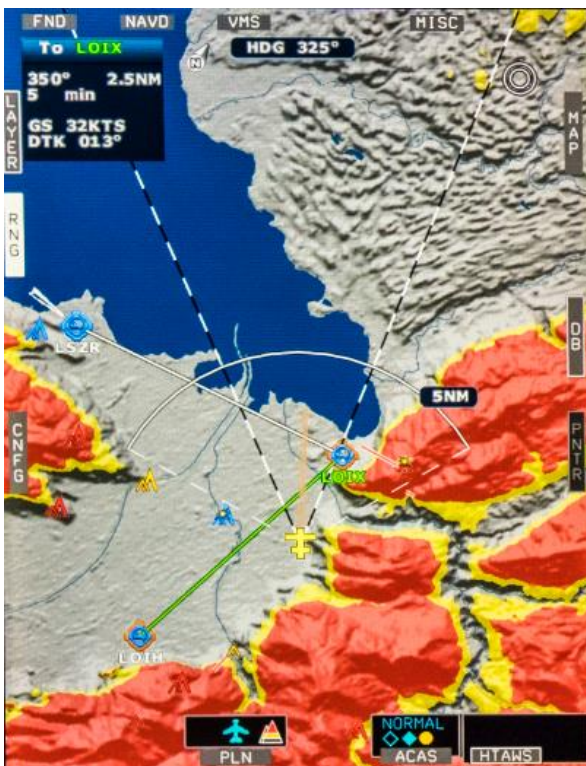


Figure 5: Height above terrain awareness

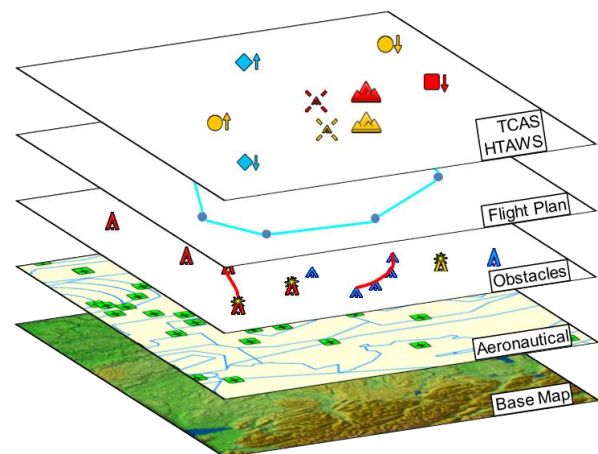


Figure 6: Organisation of geographic and geo-referenced layers

5.4. Geographic and Georeferenced Database

The primary mean of providing external situation awareness is by certified geographic data that include certified database of elevation data, obstacles, digital maps, aeronautical and cultural data. The procedure for generation and loading data in the avionics is certified according to DO-200 to ensure correctness and incorruptibility in the data chain. Dedicated data tools process and convert raw input data to a proprietary data format which can be loaded on the MFDs. Periodic update of the cyclic databases such as AIRAC cycle (obstacles, aeronautical data) ensures that the helicopter has an up to date database necessary for the external situation awareness. As helicopters tend to fly low in unprepared areas, the availability of accurate obstacle data in remote locations is necessary to ensure that awareness is provided where most needed.

Thus, the main challenges for the databases lie in terms of the resolution, completeness and accuracy of the source data. Elevation data is available in the form of digital terrain elevation data (DTED). The resolution is measured in terms of the post spacing and different levels of resolution are available. DTED Level 0 has a post spacing of 30 arc-second which measures about 900m post spacing at equator. The memory requirement for DTED Level 0 over a 1°x1° area is about 30 kilobytes. DTED Level 1 has a post spacing of 3 arc-second which measures about 90m at equator. The memory requirement for DTED Level 1 over a 1°x1° area is about 3 megabytes. DTED Level 2 has a post spacing of 1 arc-second which measures about 30m at equator. The memory requirement for DTED Level 2 over a 1°x1° area is about 30 megabytes. A qualitative view of the elevation data at different levels of resolution is shown in Figure 7. For even smaller post spacing such as 10m, the memory requirement per unit area increases by an order of magnitude. The memory size needs are indicative and do not consider data compression. Thus, on the one hand higher resolution elevation data gives better visualization and greater fidelity in the terrain alerting owing to a higher granularity. On the other hand, database coverage, memory size and computing performance are affected by the size of the database. The performance and

functional optimization has led to the use of Level 1 data for the awareness functions. However the trend is towards the use higher resolution databases for the awareness functions.

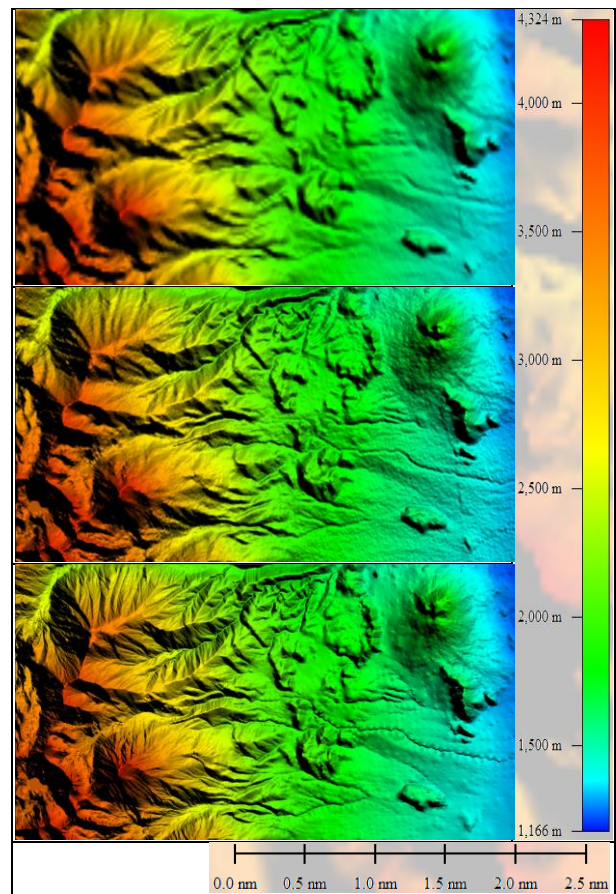


Figure 7: Visualization of DTED: 3 arc-sec (top), 1 arc-sec (middle), 0.3 arc-sec (bottom)

5.5. Information presentation and HMI Concept

The state-of-the-art in Helionix® is consistent with previous avionics suites, such as AHCAS® embedded in H225, in order to keep a filiation link and a family concept. So, the display concepts common to ACAS and HTAWS in Helionix are largely inspired from AHCAS® implementation.

For helicopter pilots, the external situation is continuously updated and partly based on the following key elements:

- The helicopter's current position and attitude in space (including height and speed), surroundings (terrain and obstacles), and current flight path with respect to those surroundings.

- The mission status and progress, including a view on probable mission duration and expected difficulties.

These elements are depicted in the display system through:

- A horizontal situation supported by FND, NAVD and DMAP format;
- A vertical situation supported by FND/SVS embedding all the DMAP, HTAWS and ACAS information;
- A visual and audio alerting presenting operational alerts such as Traffic advisories or terrain alert;
- A clear view of the configuration and of the status of the functions generating such information.

Information and alarms coming from ACAS, HTAWS and DMAP functions are presented in a unique and consistent way in the whole display (DMAP, NAVD, FND, SVS and audio). The control and moding, irrespective of the format (DMAP, NAVD, SVS and FND) and the function (HTAWS, ACAS, DMAP) uses the same rules so that the pilot follows always the same way to perform an action either to acquire information or to resolve a conflict.

The development and the integration of these new functions has been done taking into account the potential for vulnerabilities linked to crew interaction. The vulnerability of the crew interactions with SVS and the side effects of its integration with FND have been formally assessed during the certification process. So the SVS displayed as background of FND is usable in any environment and mission phase (e.g. CAT A take-off or excessive attitude). Awareness information is supported by displays using large palettes of colours. The design has been tailored in order to be used in any kind of mission and environment including clear day, night and using night vision equipment.

Moreover, the Helionix® part time display of vehicle parameters concept, developed to free up essential cockpit space, permits the pilot to safely display relevant mission information in his immediate field of view. Such characteristics permit to reduce pilot workload and complexity

and to increase situation awareness and mission involvement.

5.6. Overview of Function Architecture

The functional features of DMAP, HTAWS and SVS described in the preceding sections provide different levels of awareness which can be summarized as follows:

- The functions aid the crew's perception of georeferenced elements (terrain, obstacles, aeronautical and cultural) with respect to the helicopter's position;
- The functions highlight the significance of specific georeferenced element(s) to the current flight dynamic situation;
- The functions provide alerts regarding potential external threats in the current flight path.

The overall functional architecture for the on-board part is shown in Figure 8. In operational mode, SVS, DMAP and HTAWS hosted applications on MFD receive data from other on-board applications including position, speeds, attitudes, altitudes, navigation data and vehicle states. Mission databases including terrain, obstacle and aeronautical data stored on the mass memory and flight crew inputs from the HMI interface are processed by the hosted application to provide the relevant output for display and alerting. Not only are the awareness functions integrated in the avionics at function and software level, but the standardised and validated HMI concept that conforms to the overall HELIONIX® HMI concept ensures a high level of integration regarding look and feel.

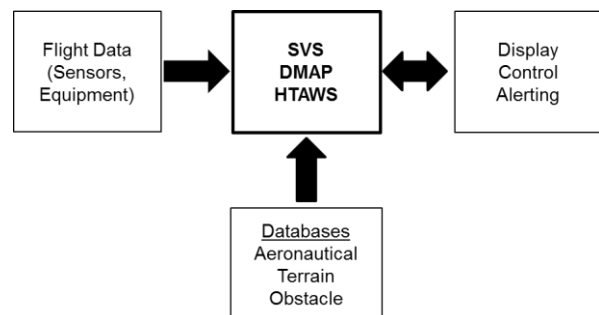


Figure 8: Functional View

6. CERTIFICATION ASPECTS AND FAMILY CONCEPT

To standardise functional features, optimise development efforts and provide unique solutions

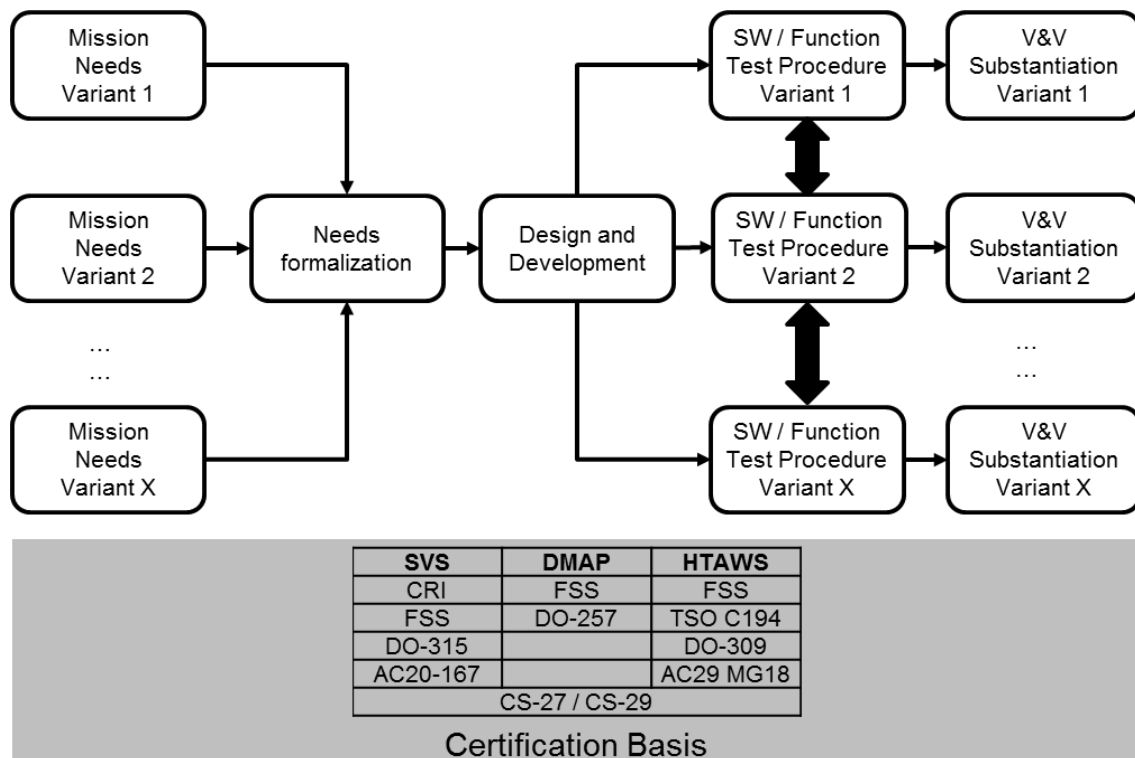


Figure 9: Standardised common development and certification methodology

over the complete fleet, the HELIONIX® awareness functions offer maximum reuse between the different helicopter variants in the HELIONIX® suite. The main challenge is to harmonize the functional needs across different missions and platforms, and to develop and certify functions that can answer to a large extent to the needs of each. The fact that the awareness functions are hosted on the MFD platforms which are part of all HELIONIX® installations greatly simplifies the aspect of reuse. The different mission needs discussed previously are analysed and formalised into requirements. The design elements are defined and developed according to established standards, guidelines and airworthiness requirements. Standardised test procedures for transversal features as well as specialised test procedures for specific functional aspects are carried out. Each new development can rely on previously qualified and certified design. For new features added in subsequent development steps, performing dedicated tests for the new and impacted features and generic tests for the transversal features provides the basis for verification activities. The overall concept is described in Figure 9. Thus, the reuse of design and test procedures not only helps reduce the

development effort across different helicopter platforms, but also ensures commonalities of the awareness functions which reduce training and maintenance efforts. Finally the validation and verification activities support the substantiation of the intended function in front of the regulatory authorities.

7. CONCLUSION

In order to support mission execution and reduce tendency to unsafe incidents, it is essential to provide enhanced awareness about the external situation using new on-board technologies. Airbus Helicopters HELIONIX® suite has achieved this goal by developing and certifying the SVS, DMAP and HTAWS functions embedded in the MFDs. These functions provide awareness with regards to terrain and obstacle proximity as well as aeronautical and cultural data with a consistent HMI concept which eases the task of identification and correlation of external visual references with information inside the cockpit. Standardisation and reuse across platforms have optimised development and certification efforts and provided unique fleet-wide features. The benefit of this approach has allowed cost, weight and space savings for the awareness functions in the cockpit.

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