MULTIHELICARE

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Abstract

The efficiency of army aviation forces is probably related to availabilty of real time intelligence data gathering and the capability of tactical situation updating. MULTIHELICARE system described in that paper has been developed to investigate and evaluate some aspects of man machine interface and datalink requirements for an efficient real time update of the tactical situation

Digital Map - Tactical Situation Management for Helicopters

MULTIHELICARE is an experimental system which has been developed by SEXTANT with the support of the STTE , Technical Services of the DGA (Délégation Générale à l'Armement). This system has been developed in the early nineties, flight tested by the CEV, french flight test center of Bretigny in 1994 and since that date is still under operational evaluation at the STAT (Service Technique de l'Armée de Terre) in Valence which is a technical service for the army aviation.

This paper will not discuss detailed operational requirements. However it has to be understood that the basic requirements of the MULTIHELICARE system were based on two assessments.

The first one is related to the use of up to date tactical situation, and therefore to be able to access it and update it as easily as possible on a single reference and interface system..

The second one is that, to be efficient this update shall be done through at any hierarchical exchanges of data.

Multihelicare Block Diagram

To evaluate this, the experimental system is composed of two subsystem which are representative of two different hierarchical level.

The first one, the "Ground System" is dedicated for use by the upper level,

The other one, the "airborne system" is for the helicopter level

Each one of these subsystems is built around a computer which integrates a digital map/ digital terrain processing and display capability, as well as associated databases.

A data link enables data exchanges between both systems. This data exchange includes a report of the current position of the helicopter as well as evolution to tactical situation and flight plan changes.

On Board Mission System

The airborne system is organised in such way to enable an efficient use with optimized crew data access and workload.

The computer/digital map generation system is coupled to the navigation system thus enabling display of current flight plan and mission profile as well as live "on image" modifications of these data.

The navigation system of the Gazelle helicopter has been modified to include gps data input capabilities.

Data exchange with ground system is performed through the digital data link provided by PR4G transmission system which is in service in french army.

Last but not least part of the system is the man machine interface which includes :

- Multifunction display currently based on 6" x 6" displays
- Direct voice input
- Joystick
- and a keyboard

The joystik, and to some extent the keyboard, is associated with icons and menus.

As usual the display of map data can be servoed to current helicopter position, moved around when using the manual mode and the joystick or settled to any geographical entry including waypoints.

Map systems functions

Map system is the basis for georeferenced functions which basically include :

- Navigation of course
- Tactical work, ie tactical situation/ damage assessment,...

Man Machine Interface shall provide easy access to any of the function of the system which in addition to those mentioned above, also include Communication management.

Basically digital data link modes can be settled and or modified in real time on board. These modes include the update rate of broadcasting the current position of the helicopter, acknowledge modes of incoming messages as well as activation/desactivation of a stealth/silent mode.

as the data managed by both airborne and ground systems are identical, ground system can be used to perform intelligence and C3I work as well as map data preparation.

In current implementation two 128 Mbytes digital rewritable optical disks are performing the mass storage function.

Geographic Data Base

Various sources of geographic informations can be used and processed to be displayed either on ground station or in the airborne system.

These sources include the digital land mass system with basically DTED and DFAD entries. More generally any source of data compliant with DIgital Geographic Exchange STandard can be used, among which Digital Chart of the World and VMAP data.

The system is not only able to display vector maps, but also raster information :

- Digitized paper maps
- Pictures

Satellites pictures and target pictures can be displayed enabling complementary work on target identification and localisation, data collection on tactical situation or improvement/refinement of damage assessment.

Navigation Work

In the past few years there has been an evolution in navigation interface requirements. Although in use since many years the CDU has in some cases, such as waypoint introduction, some limitations. MULTIHELICARE enables the crew to build flight plans, create waypoints and routes directly on image with map background. In addition, the elevation processor is able to compute and display safety altitudes for each leg.

Another feature provided by the system is the ability to receive or send flight plans and navigational data from or to another station.

Finally as most of the work is done on the multifunction display some symbology has been added to present steering and level indicators to replace missing HSI data.

Tactical Work

As discussed in the introduction, one of the primary objectives of MULTIHELICARE was to provide the crew with the ability of working with an up to date tactical situation. This can be achieved with both the digital datalink and an efficient Man System Interface.

The airborne tactical interface include capabilities for editing, creating and modifying tactical symbology. Displacement of stations and symbols can also be achieved.

As tactical situation is mostly related to geographical references a trade-off between map scales and tactical datas has to be dealt with to avoid image clutter and provide easy to understand display at any scale; This is achieved by hierarchical automatic selection.

The symbology set is of course based on NATO symbology.

Direct Voice Input

I shall emphasize here that MULTIHELICARE is probably the first airborne operational application of direct voice input, at least in western Europe.

Direct Voice Input (DVI) is there used complementarily with other features such as menus and icons. The key advantadge of DVI is the ability of entering high level or complex controls with a single command. Another feature is the capability of entering a complex NATO tactical symbol at the currently pointed location.

MULTIHELICARE's DVI performances are achieved with a vocabulary of about eighty words, sentences of up to six words and a branching factor of 6. The identified recognition rate (sentence based rate) is between 93% and 96% at first elocution and above 97% at first repetition. Such performances have also been demonstrated by SEXTANT DVI for fighter aircrafts, clearly indicating state of the art capabilities.

Finally, the initial system was designed with a french syntax. A german syntax has been customized with the same level of performances to enable german pilots to fly and evaluate the system

Application Examples

Application examples are shown with pictures of screen picked-up in different configurations and modes.

Conclusion

After more than two years of full scale evaluation by operational people of the STAT, one can state that MULTIHELICARE provides the crew with adequate capabilities to deal with tactical situation and navigation work.

Such a system may put some emphasis on requirements for map displays and man machine interface systems for future combat helicopters .

On the other hand, work is never finished and some of the functions of the system could probably be enhanced to widen operational scope and to integrate other systems such as countermeasures, sight/targeting and other interface devices such as Helmet mounted displays and 3D audio systems.

Once again, I would like to thank here all the people who have been involved in the development and evaluation of the system with a particular attention to the DGA for their support and the STAT for their operational advices.

DIGITAL MAP DISPLAY

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Abstract

Terrain elevation and terrain planimetry data availability has been made easier and faster through the use of exchange standards and satellites pictures. In addition to digitized paper maps, vector information when properly processed provides the crew with valuable informations. This paper describes some technical aspects related to airborne map displays based on digital terrain data.

Introduction and History

SEXTANT has been involved in airborne map displays since the early seventies . Therefore it has been associated to any step of the technological progress towards current state of the art.

The story started in the early seventies when map displays where based on a moving film projected on a frosted glass

Further evolutions introduced a flying spot, thus enabling both a remote map reader and the capability for overlays as the signal was basically a video signal.

In the second half of the eighties, the introduction of digital terrain databases as well as the large increase of digital processing capabilities made it possible to achieve realtime on board digital terrain display. With the support of the french DGA, SEXTANT developed the DRACAR demonstrator which was dedicated as technological development of the RAFALE program.

General Block diagram

The terrain elevation processor is organized around an intermediate terrain memory and dedicated hardware This architecture enables to both :

- retrieve data from mass storage device according to helicopter position and center of image displacement
- provide real time update of image according to helicopter position and heading.

The update of data into the intermediate memory is done according to a bidirectionnal "waterfall-wrap around" indexation scheme.

The extraction of the data from the memory for image generation is done by incremental address generation according to scale and display modes. Specific adressing scheme is used when building Elevation/Distance profile display mode.

A real time computation of hue, light and saturation is done to perform rendering of elevation, slope, as well as features such as cities, water areas and power distribution lines

Display modes

Display modes shall enable a more efficient access to elevation data as well as easier correlation with the external world. Display modes include :

- Center / Decenter to enhance look ahead capability
- North up / Track up
- Elevation / Distance Profile
- Ground Collision Avoidance Warning

In addition different declutter levels enable to adapt image content to task requirements.

Display Human Factor issues

It is not the intent of that paper to review a detailed and exhaustive list of human factor issues related with vector map and terrain elevation display functions. However one has to be aware that some problems may arise .

Shading and elevation perception. An accurate visual perception of elevation data is provided through the use of shading. This shading is calculated in real time when the image is generated and light source can be located in any location. However the usual way is to have the light source in North West location of the screen, which implies that south east slopes of hills must be shaded. The opposite direction may generate misinterpretation in such way that ridges and valleys can be interverted.

Ground collision avoidance modes . Three colors GCAS coding provides information about terrain above the current flight level which to some extend shall be interpreted as a requirement "to climb", however there is a lack of information for " to dive" capability..

Color coding and overlays . To have an efficient elevation and features representation a large part of the color spectrum might be used, therefore the use of overlays shall be consistently analyzed to avoid any loss of information.

Projection solving

The basic problem is to be able to continuously display projected map images with limited errors whatever the size of the database is.

One possible solution is to store terrain information in spherical L, G geographic reference system, and perform map projection (transform to X,Y image coordinates) in real time when generating displayed image.

Elevation Processor architecture basically implements various map projections, among which : Lambert, Mercator and Transverse Mercator projection.

Database content and organisation

Another issue to be addressed when building a map display system is the problem of data storage. The improvement in storage capacities for either static memory or disk based system make it more possible to achieve wide area storage. However at least two questions have to be adressed :

- The first one is related to the content of the database files according to the various scales (generalisation issue),
- The other one is related to data compression.

Error free compression is of particular interest when dealing with elevation because if errors cannot be identified from the visual stand point, they become critical when data are used for safety level or GCAS computation. Real time decompression capability has also to be considered.

Application exemples

application examples of terrain elevation and map displays are shown based on pictures taken on MULTIHELICARE screen

Conclusion

Large development in map displays have been made in the field of digitized paper maps. Beside the informations available with that type of maps, digital terrain display provides valuable 3D data enhancing the safety capabilities of navigation system and crew situational awareness.