EIGHTEENTH EUROPEAN ROTORCRAFT FORUM

J - 07

Paper N° 112

Gyrostabilized sighting systems for air-to-air combat helicopters

A. Simonot
SFIM, Massy, France

September 15-18, 1992

AVIGNON, FRANCE

ASSOCIATION AERONAUTIQUE ET ASTRONAUTIQUE DE FRANCE

Gyrostabilized sighting systems for air-to-air combat helicopters

A. Simonot
SFIM, Massy, France

1 Introduction

Since its foundation, SFIM has specialized in the design and manufacture of all types of aeronautic equipment for airplanes and helicopters.

With the spectacular development of the helicopter and mainly the military applications of this aircraft SFIM has become one of the leading manufacturers of stabilized sighting systems.

2 Gyrostabilized sighting systems

The design of the first gyrostabilized sighting system was born out of the requirement to fire at long range anti-tank missiles from helicopters despite vibrations and the unsteadiness of the carrier.

The performances of this sighting equipment in target detection and identification beyond the range of the opposing weapons make an excellent observation facility.

A family of day sights has been developed including different functions.

The high level stability of the line of sight allows accurate angular information and laser range-finding or designation at long range.

As soon as thermal imagers were introduced, they were adapted to sights so as to extend the helicopter mission capabilities by night and in poor visibility conditions with the same performances as by day. VIVIANE is able today to fire the HOT anti-tank missiles at 4 km by night with a hit probability of more than 80%.

3 Air-to-air combat between helicopters

3.1 Modern combat conditions

The conditions of modern combat are high mobility of the forces, vast uncontrolled spaces between the different units deployed on the terrain and sudden changes of situation.
The main threat comes from significant tactical support aviation including notably assault helicopters. The major adversary of the combat helicopter is the enemy helicopter.

3.2 The support and protection helicopter (HAP) concept

Using tactical flight, helicopter encounters are for the most part at short range. The adapted on-board armament must allow a very short reaction time. The assistance of a fire control system with automatic target tracking is necessary to reduce the crew workload. A fire control system allows short-range tracking of aircraft flying at low altitude or helicopters in tactical flight.

The on-board armament comprises a high rate automatic gun, air-to-ground rockets and air-to-air missiles.

The fire control system includes a combination of optical systems for the acquisition of targets and armament computers, which generate the weapon aiming data from the optical systems information.

Three kinds of optical systems are used : helmet-mounted sight or integrated helmet for each crewmember, head-up display for the pilot and gyrostabilized sight at the on-board chief's disposal.

The gyrostabilized sight is the main mission equipment which allows target acquisition at long ranges. Its line of sight is the reference of the weapon system.

3.3 The HAP gyrostabilized sight

The gyrostabilized sight of the support and protection helicopter (H.A.P.) is a roof-mounted sight. Its is preferred to a mast-mounted sight to minimize the aerodynamic surface. It can be divided into three parts :

- the gyrostabilized platform`
- the lower optical bloc
- the interfaces with the crew, with the other mission equipment and with the helicopter.

The gyrostabilized platform includes direct view optics and different sensors such as a T.V. camera, thermal camera, laser range-finder and boresighting device.

The gyrostabilized platform enables identification of targets with a tenfold D.V.O. magnification and narrow field of view of the thermal

camera at a mean range of 5 km.
Targets are acquired by aiming with a graticule which materializes the line of sight. This is realized either by the chief on board and copilot thanks to the gyrostabilized sight control stick or from servoing the gyrostabilized sight on designation instructions provided by the crew's helmet mounted sights.
Video signals from T.V. or thermal cameras are processed to localize the angular position of the target with the line of sight and deliver signals to the sight electronics unit and to slave the line of sight with the target . The principle of this automatic tracking is a self-adaptive structure to allow tracking despite target evolutions and variations in contrast between the target and the landscape background.

A high rate laser range-finder (around 20 Hz) enables gun and air-to-air rockets firing at short range against fast moving targets.

The boresighting of the different optical channels is automatic in flight by localizing an internal boresighting spot.

The lower optical bloc consists in an optronic system for image mixing and presentation to the copilot through an articulated eyepiece arm or to a head-down display.

A digital sight electronics unit provides the different functions for the sight operations such as the power supply, stabilization electronics and sight control circuits. It includes a large computing capacity for processing the angular information including filtering and corrections of errors dues to the sight suspension. It also includes autotracking electronics and electrical interfaces between the sight, the sensors and the other helicopter equipment, through the BUS system.

The sight is soft mounted to dampen vibrations. The sight's movements with reference to the helicopter structure must be known. An optronic device integrated in the sight measures these angular movements.

The gyrostabilized platform is covered by a dome (a geode) to minimize the effects of aerodynamic strengths at high speed and allow the best integration of the sight in the structure of the helicopter.

3.4 The Gunner - Pilot

For comparatively short range firing, the pilot can detect and identify a target. He can point the helicopter and therefore the armament by aiming the target with the head-up display graticule. He can also designate and lock the homing head of an air-to-air missile onto his target using the head-up display. The pilot must orient the helicopter in the direction of the target, however he cannot directly aim the target with the helicopter due to the considerable variations of the helicopters attitude in tactical flight. The pilot therefore merely brings

the target within the scanning angle of the homing head and then aims the target by the manual control of the homing head.

It is quite probable that this manoeuvre will turn out to be rather tricky at comparatively short range : flying the helicopter at low altitude in a combat atmosphere and at the same time controlling the axis of the homing head with an accuracy of approximately 1 degree.

4 Air-to-air missiles from helicopters

4.1 General use

A helicopter fitted with air-to-air missiles can expect to successfully carry out surprise attacks thanks to a firing range of over 4 km. Even if the enemy is not totally surprised, this armament allows the helicopter to hit targets out of the range of guns and rockets.

Air-to-air missiles can fire targets over 4 km away. To make the most of this performance, the crew must be able to :
- detect and identify targets over this range
- designate the target to the missile homing head and lock on
- keep the firing sequence to the bare time minimum, from the detection of the target until the release of the missile.

Then a gyrostabilized sight can be a determinant help.

4.2 Air-to-air missile firing by the copilot

The crewmembers are capable of detecting a helicopter 4 to 5 km away, but at such distances they are totally incapable of identifying a flying target with the naked eye. In fact, the problem is rather like detecting and identifying armoured vehicules at similar ranges. There is a solution for anti-tank helicopters which has been used for years : a magnifying telescope which must be gyrostabilized to offset movements and vibrations of the helicopter. The effectiveness of SFIM sights M334, M397 and VIVIANE no longer needs to be proven. This can be a little more difficult with fast moving targets and the designation by a millimetric radar could be successful.

It is now possible to detect the other helicopter almost on the horizon. Identification is also a reality at the desired ranges of 4 to 5 km.

Special care has been taken to minimize the operation time and the firing sequence of the air-to-air missile. The basic firing problem is how to designate the target to the homing head and to lock this head onto the target.

Hence the idea of the copilot being responsible for all firing, through his gyrostabilized sight.

Once the copilot has detected and identified the target, he pre-

activates the missile and requests the pilot to point the helicopter in the direction of the stabilized line of sight given on his head-up display symbology. The help of the automatic tracking minimize the acquisition time. Then the copilot activates a control to slave the homing head axis with the stabilized line of sight.

Once the homing head axis is oriented towards the target, the homing head detects the target (audiovisual signals). The homing head automatically locks on to this target and from that instant onwards, the stabilized line of sight is slaved with the homing head axis. This permutation has many advantages, notably to check that the homing head remains locked onto the right target. The copilot can then proceed to launch the missile.

4.3 Information to the copilot

The information given to the copilot comes from the missile control panel and from the CRT integrated in the gyrostabilized sight.

The missile control panel is specific for each kind of missile.

The sight's CRT gives different information :

- **Helicopter** - the copilot doesn't need flight control information apart from a master alarm, helicopter heading and ground altitude.
- **Gyrostabilized sight** - over and above the CRT application, the line of sight is materialized in the center of the image by an optically generated cross. This line of sight is to be taken as the reference, especially for all boresighting operations.
  An azimuth scale and an elevation scale must appear at the edge of the CRT screen. The line of sight and the homing head axis are marked on each scale with limits for prepositioning.
- **Missile** - Data for weapon system management must be shown and indications for the firing sequence.

4.4 - The pilot's role

Throughout these operations, the pilot has to maintain the helicopter axis within the center of a symbology window on his head-up display.

Since the pilot basically looks out of the front glass, the information needed should be made to appear in the head-up display.

The pilot needs essentially flight control information and basic indications enabling him to bring the helicopter axis into the general direction of the stabilized line of sight until he visually acquires the target.

As for the copilot, the information will be supplied to the pilot in forming him of symbols laid over the image of the landscape seen outside the helicopter.

5 Scout and support light helicopter

Headquarters need to know as soon as possible and accurately the position of the adversary, identify threats and be informed of the state of the terrain.

The air-to-air combat helicopter described above can accomplish this mission with a self-contained navigation unit to geographically localize targets. This navigation unit can include a Doppler radar or a GPS transceiver.

A complete mission equipment system for scout and support light helicopters can be proposed and built around a gyrostabilized sight with an integrated laser range-finder.

The system's electronics unit receives informations from the different parts of equipment on the helicopter :

- bearing and range of the target supplied by the gyrostabilized sight
- position and ground speed of the helicopter from the geographic reference system
- attitude of the helicopter with respect to the magnetic North and vertical.

The same electronics unit can calculate :

- the indications of target co-ordinates
- the armament aiming parametres.

An interface between the electronics unit and the on-board communication installation enables the transmission of data on the tactical situation.

The system can be also linked to a map display in order to visualize all the stored data.

This system is modular. It's therefore possible to find a configuration that solves intermediate problems and which is tailored to the user's needs.

6 CONCLUSION

The SFIM company benefits from a long experience of gyrostabilized sights and is a world leader in the design of integrated observation systems.

This experience not only enables the mastery of new techniques and the design of leading edge products, but mainly highlights the irreplaceable advantage of the know-how of teams working together for more than twenty years.

SFIM has succeeded in becoming a leader in international competition, thanks to its teams, which are always one step ahead in research.

SFIM already holds this technological edge in night vision and in the understanding of future systems. SFIM offers military users the best survivability chance and the shortest reaction time over their adversaries.