

CASE STUDY

UNMANNED SURFACE VEHICLES (USVs)



> Overview:

Collision avoidance for USVs using thermal imaging technology

Unmanned Surface Vehicles (USVs), ranging from small USVs to large, long-endurance XLUSVs, are transforming maritime operations across defense, commercial, and research sectors. As autonomous navigation advances, ensuring their safe and reliable operation in dynamic and often unpredictable maritime environments has become a critical concern. One of the primary operational risks for USVs is collision—with other vessels, floating debris, or maritime infrastructure. To meet this challenge, **SPYNEL-F**, a thermal panoramic camera developed by **HGH**, offers an innovative solution. Equipped with **CYCLOPE** AI-based analytics (GAIA), it provides day-and-night situational awareness, real-time object detection, classification, and remote surveillance capabilities.



> Challenge:

Navigating autonomously in complex marine environments

Autonomous USVs must navigate through the same waters as manned vessels, yet without human oversight on board. Their systems must:

- Ensure self-protection and safety of other vessels.
- Operate in compliance with maritime navigation rules (COLREGs).
- Maintain reliable performance regardless of sea state, visibility, or clutter.

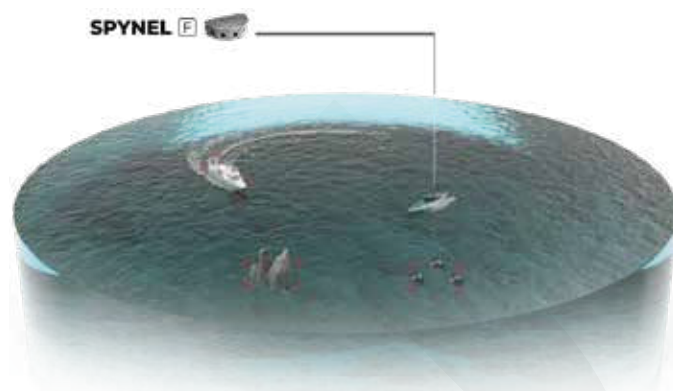
Key threats to USV Navigation:

- **Large vessels:** Tankers or cargo ships that pose major collision risks.
- **Static objects:** Rocks, small islands, buoys, or offshore structures like wind turbines.
- **Floating debris:** Wood, sea mines, or iceberg fragments that often go undetected by radar.

- **Fast and small crafts:** Jet-skis, RHIBs, or other low-RCS (Radar Cross Section) threats.

- **Maritime infrastructure:** Bridges, piers, or breakwaters in congested zones.

Traditional radar-based solutions face limitations in detecting small, fast, or stealthy objects—especially in cluttered or rough sea conditions. A new approach was needed to enable true **sense-and-avoid autonomy** for USVs.



> Solution:

Deploying SPYNEL-F and CYCLOPE for thermal-based collision avoidance

SPYNEL-F Thermal Camera:

The SPYNEL-F panoramic infrared camera is a passive, high-resolution thermal imaging system designed to deliver panoramic situational awareness, regardless of lighting or weather conditions. Its advantages include:

- **Panoramic field of view:** Available in 110°, 180°, and full 360° configurations.
- **30Hz frame rate:** Smooth real-time imaging, suitable for fast threat detection.
- **Compact & lightweight design:** Ideal for small USVs with strict payload constraints.
- **Embedded digital stabilization:** Its wide vertical field of view allows roll&pitch compensation even in high sea state level.
- **No mechanical moving parts:** To resist vibrations, shocks and motion in rough seas.



Cyclope Graphical User Interface

CYCLOPE Software & GAIA Artificial Intelligence:

Paired with CYCLOPE, SPYNEL-F uses real-time video analytics to:

- **Automatically detect, track, and classify targets.**
- Differentiate between static and moving threats.
- Provide **alarm notifications** directly to the USV's collision avoidance module.
- Display real-time panoramic video (annular or strip) with zoom-on-target functionality.

Key Benefits for USVs:

- **Detection of low-RCS objects:** Thermal sensors detect threats that radar cannot, such as wooden boats or floating debris.
- **Fully passive system:** Undetectable and unjammable—ideal for defense and stealth missions.
- **Night and day operation:** Infrared technology functions reliably in complete darkness.
- **Remote monitoring:** Enables a distant operator to take control or monitor in real-time.
- **Interoperability:** Cyclope supports standard maritime systems (AIS, ECDIS, ONVIF, etc.).
- **Adaptability:** Operational in harsh maritime environments and high sea states.

> Conclusion:

As maritime autonomy scales, the need for **intelligent, reliable, and versatile sensor solutions** becomes vital. The integration of **SPYNEL-F** and its **CYCLOPE software** provides USVs with the ability to:

- **Navigate safely and autonomously** in congested or high-risk areas.
- Detect and avoid both predictable and unpredictable hazards in real time.
- Operate effectively across multiple mission profiles—defense, surveillance, or logistics.

By delivering **unparalleled thermal coverage, real-time analytics, and compact hardware**, the SPYNEL-F system equips USVs with the awareness needed to match and exceed the safety of manned vessels. In doing so, it lays the foundation for safer, smarter, and more autonomous maritime navigation.