Visual Predictive Maintenance and Augmented Reality

SIPAL, an Italian company with decades of experience in engineering applied to military aviation, is now proposing a **technological evolution** in predictive maintenance for the aerospace sector. Building on the expertise developed through the IPAC (Intelligent Procedure Assistance Checker) project, designed to support training and maintenance activities in complex environments through Augmented Reality, SIPAL focuses on high-technology solutions integrated with Artificial Intelligence. From this foundation emerged the collaboration with Odysight.ai, a company specializing in the development of advanced optical systems for the visual acquisition and analysis of components and structures. Odysight.ai provides the **sensory infrastructure**, consisting of intelligent micro-cameras capable of detecting physical and geometric anomalies in real time. **Predictive data processing** is carried out through AI algorithms developed in close synergy with SIPAL, which integrates them into complex aeronautical architectures by leveraging its engineering expertise.

VPM: predictive maintenance becomes visual

Visual Predictive Maintenance (VPM) enables the identification of anomalies and the anticipation of potentially catastrophic failures through the combined analysis of visual data (images and video) and sensor data (vibration, temperature, pressure). This capability is essential in highly complex technical environments, where continuous, non-invasive monitoring allows timely intervention, reducing time, costs, and operational risks.

Augmented Reality for the operator

Augmented Reality (AR) overlays operational instructions, data, and contextual information onto the real world, providing technicians with immediate visual support. This approach enables rapid diagnostics and the identification of corrective actions, reducing errors and execution time.

New diagnostic procedures for corrective maintenance.

The combined application of VPM and AR provides concrete benefits in terms of:

- **Safety:** risk reduction through early detection of anomalies
- **Efficiency:** targeted, less invasive interventions
- **Operational continuity:** reduced downtime and optimized maintenance cycles

TruVision: a concrete case on the HH-139B

Between February and March 2025, at the Italian Air Force Flight Test Department, TruVision was tested, a non-invasive PHM (Prognostics and Health Management) system developed by Odysight.ai with engineering support from SIPAL. Installed on an HH-139B helicopter, the system is based on a network of micro-cameras positioned near critical components. The collected images are analyzed in real time by onboard computing units using AI algorithms capable of identifying deviations from reference parameters. Through integration with SIPAL's IPAC system, operators can access the real-time visual stream via AR headsets, without the need to remove panels or physically **access components**. An additional key element is the use of blockchain technology, which ensures the traceability and integrity of the collected data.

Future developments

Planned developments include the integration of infrared sensors to detect corrosion phenomena and structural stress, as well as the adoption of predictive maintenance based on advanced digital models. The long-term objective is to converge toward solutions based on digital twins and centralized predictive dashboards, guiding maintenance decisions through historical and real-time data, **alongside regulatory evolution** in collaboration with the relevant Design Authority.

Challenges ahead

For effective adoption, it will be necessary to:

- Integrate with legacy systems and meet aeronautical certification requirements.
- Ensure data reliability and reduce false positives.
- Strengthen the cybersecurity of connected systems.

Conclusions

The combination of Visual Predictive Maintenance and Augmented Reality marks a paradigm shift in aeronautical maintenance. Technologies such as TruVision enable increasingly early diagnostics and targeted, well-documented interventions, enhancing flight safety while reducing operational costs. SIPAL and Odysight.ai, through a synergistic integration of advanced sensing, Artificial Intelligence, and Augmented Reality, are charting the course toward more intelligent, proactive, and sustainable maintenance.

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Odysight AI