



# ROV-Based Digital Inspection and AI Analytics for Offshore Asset Monitoring

How ROV inspection and AI-assisted analytics support safer, more consistent offshore and underwater asset monitoring

## Executive Summary

Offshore and underwater infrastructure operates in environments that make regular inspection difficult. Wave loading, corrosion, marine growth, and seabed scour affect submerged components continuously, and much of this damage is invisible from the surface. Inspection is necessary to assess asset condition, but the underwater environment itself creates constraints around access, depth, visibility, and data consistency.

Remotely Operated Vehicles (ROVs) equipped with sensor payloads and integrated with AI-based analytics offer one approach to these challenges. The operator remains on the surface while the vehicle captures visual, acoustic, and dimensional data underwater. AI-assisted processing then organises the raw inspection data into structured outputs, including enhanced imagery, automated defect classification, 3D reconstructions, and condition reports.

This paper describes how the technology works in field conditions, the type of data it produces, and its role in offshore asset integrity management.

## Why Underwater Inspection Is Difficult

Offshore structures such as fixed platforms, Floating Production Storage and Offloading (FPSO) units, and subsea pipelines are made up of complex systems: jackets, decks, piles, risers, conductors, bracings, mooring lines, and seabed-laid pipelines. The submerged portions of these structures are exposed to wave action, electrochemical corrosion, marine growth, and seabed movement. Over time, this leads to cracks, coating damage, deformation, material loss, and pipeline free spans.

The underwater environment makes inspection inherently constrained. Visibility is often poor. Currents can be strong and unpredictable. Deeper sections (beyond approximately 50 metres) require specialised saturation diving, which is resource-intensive and involves a limited number of qualified personnel. Confined spaces such as pipelines, intake wells, and internal compartments may restrict physical access entirely. And where inspection is possible, records



often depend on manual observations, making repeat comparison across inspection cycles inconsistent.

These are not limitations of any single inspection method. They are characteristics of the operating environment. Any inspection approach, whether manned or unmanned, must account for them.

ROV-based inspection combined with AI analytics is one way to work within these constraints. The sections below describe the system, the workflow, and where it has been applied in the field.

## **ROV Inspection: The Technology and How It Works**

An observation-class ROV is a compact, remotely piloted underwater vehicle connected to a surface control unit through a tether. The tether supplies power and transmits live video and sensor data. The vehicle is operated from the surface and carries a sensor payload configured for the specific inspection scope.

**Cameras.** A high-definition camera (HD or 4K) captures close-up footage of structural surfaces, welds, and visible defects. Dual camera configurations allow simultaneous wide-angle and close-up views.

**Imaging Sonar.** In low-visibility conditions where optical cameras cannot produce usable footage, imaging sonar uses acoustic signals to navigate and identify structural features. This is common in turbid water, silt-heavy environments, and confined spaces.

**Profiling Sonar.** Generates cross-sectional measurements of tunnel or pipeline interiors. This data helps identify deformation, deposit build-up, or changes in internal geometry over time.

**Laser Scaling.** Projects reference points onto the inspection surface, allowing defect dimensions (crack length, coating damage area, corrosion patch size) to be measured directly from the video feed.

**Doppler Velocity Log (DVL).** Tracks vehicle position underwater so that inspection findings are spatially referenced and can be revisited during future surveys.

All inspection data is recorded and transmitted live to the surface. The pilot follows a structured inspection sequence, carrying out repeat passes where additional detail is required. The output is a timestamped, geo-referenced digital inspection record of the asset condition.



## How AI Processes Inspection Data

An ROV inspection produces large volumes of video, sonar, and telemetry data. Reviewing this manually takes time and may vary between reviewers. AI-assisted processing organises and interprets the data more consistently.

**Image enhancement.** Underwater footage is commonly affected by backscatter, colour loss, and reduced contrast at depth. Deep learning-based algorithms correct these distortions, improving image clarity and making structural defects easier to identify during review.

**Automated defect detection.** Machine learning models process inspection footage and classify features such as corrosion, cracks, coating damage, marine growth, and structural deformation. Applying the same classification criteria across inspection cycles improves consistency when comparing asset conditions over time.

**3D reconstruction and point cloud modelling.** Photogrammetry combines overlapping inspection images with laser measurement data to generate scaled 3D models of the inspected structure. For pipelines and confined spaces, profiling sonar data is used to create dense point cloud maps of the interior geometry. These models support remote measurement, dimensional comparison, and maintenance planning without requiring additional field visits.

Using laser-based proximity sensing and triangulation techniques, the 3D reconstructions provide precise area and volume measurements of material wear, section loss, or deformation. This gives engineers a quantitative basis for maintenance decisions rather than relying on visual interpretation alone.

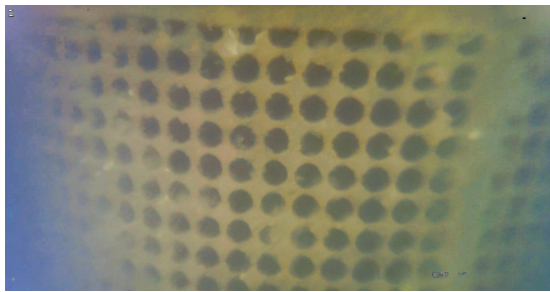
**Automated reporting.** Depth, heading, water temperature, timestamps, and vehicle position are recorded throughout the inspection and overlaid onto the inspection record. AI-assisted workflows compile findings, annotated images, sonar profiles, and telemetry into structured reports, reducing the time spent on post-processing.

## Field Applications

The following deployments represent different operating environments and asset types where the technology has been applied under field conditions.

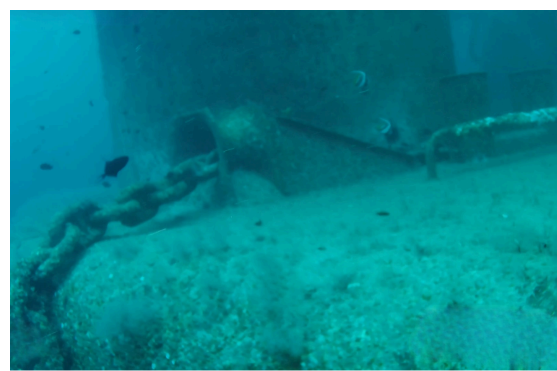
## Seawater Intake Well Inspection

An industrial facility required inspection of its seawater intake well substructure. The environment was confined and turbid, with limited optical visibility. An observation-class ROV fitted with an HD camera, imaging sonar, and DVL carried out the inspection to assess sludge accumulation, silt deposits, and structural condition. Imaging sonar supported navigation where visibility was too low for camera-based assessment. Defect dimensions and pump intake clearances were documented using video and photographic records.



## Offshore Touchdown Monitoring

During an offshore installation campaign, flowlines and umbilical lines required monitoring as they were laid on the seabed. An observation-class ROV with dual HD cameras, optical zoom, imaging sonar, and DVL monitored the touchdown point, carried out the post-lay as-laid survey, and transmitted live video and positional data to the surface team during the operation. The real-time data feed allowed the installation team to make decisions during laying operations rather than waiting for post-installation review.





## Safety, Data Quality, and Long-Term Value

ROV-based inspection changes how underwater inspection data is collected and managed across repeated inspection cycles.

**Safety.** Personnel remain on the surface during inspection activities. In hazardous underwater environments, including confined spaces, deep water, and areas with strong currents or poor visibility, this reduces operational risk.

**Data quality.** Inspection findings are timestamped, geo-referenced, and digitally recorded. This creates a format that can be reviewed, shared, and compared during future inspections, rather than relying on manual notes or individual recall.

**Value across inspection cycles.** Repeated inspections using the same methodology build a historical condition record of the asset. Operators can track corrosion growth, deposit accumulation, or structural changes over time. This supports condition-based maintenance planning, where decisions are driven by measured inspection data rather than fixed calendar intervals.

Regular AI-assisted ROV inspections reduce the gap between what is happening underwater and what operators know about it. Over multiple inspection cycles, this data becomes increasingly useful for predicting maintenance needs and extending asset life.

## Conclusions

The deployments described in this paper show that ROV-based inspection with AI-assisted analytics is being used in confined spaces, turbid water, and live operational conditions. The technology does not replace the need for sound inspection planning, qualified operators, or engineering judgment. It provides a way to collect more consistent data, more safely, across environments that are difficult to access by other means.

For asset owners and operators, underwater inspection programmes increasingly depend on selecting the right sensor payload for the inspection scope: camera systems for visual assessment, sonar for low-visibility navigation and profiling, laser scaling for dimensional measurement, and DVL positioning for spatial referencing. AI-assisted data processing improves consistency across inspection cycles and reduces manual effort during post-processing.



Inspection quality depends on the inspection process, operator capability, and the reliability of the recorded data. Technology is a tool. The value it delivers depends on how it is used.

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## About EyeROV

EyeROV (IROV Technologies Pvt. Ltd.) is headquartered at Maker Village, Kerala Technology Innovation Zone, Kochi, India, with a regional office in Doha, Qatar. The company designs, manufactures, and deploys ROV systems with integrated AI analytics for offshore, industrial, and infrastructure inspection applications across India, the GCC, and Southeast Asia.

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