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The Power of Image Analytics in Mitigating Corrosion

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The Power of Image Analytics in Mitigating Corrosion

How Image Analytics Reduced Data Capture Costs by 90% and Inspection Time by 50% for Two Operators

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Introduction

If not properly identified and managed, corrosion can have a catastrophic impact on a facility. According to the NACE International Impact report, the cost of corrosion and corrosion management for the global oil and gas industry amounts to USD $375 to $875 billion per year [1]. To mitigate the cost of asset failure and downtime that can result from corrosion, facilities must adopt a robust, proactive approach to corrosion assessment and mitigation. However, proactive corrosion management requires a sizable amount of data collection, processing, and interpretation, and many facilities struggle to allocate the budget and resources needed for this approach.

Among the emerging technology and methodologies that are being developed by the industry to address the challenges of adopting a more proactive approach to corrosion management, recent advancements in visual data capture and image analytics have proven to be an effective tool for facilities gathering and processing large amounts of visual data. With these advancements, facilities can systematically identify external corrosion and visual defects, trend corrosion over time, and optimize and automate follow-up maintenance, resulting in more reliable operations and a reduction in inspection and maintenance costs.

In this article, we'll discuss two use cases of how advanced visual data capture and image analytics can be used across multiple industries to drive better reliability decisions:

1. **Coating Optimization for the Upstream Industry:** Advanced visual data capture and image analytics used to optimize the coating program while reducing the cost of conventional laser scanning by 90%.
2. **Systematic Identification of External Corrosion in Midstream and Downstream Industries:** Advanced visual data capture and analytics used to systematically identify external corrosion in midstream and downstream facilities, enabling reliability leaders to drive better and faster decisions and reducing inspection time by 50%.

Corrosion Study for an Upstream Facility

Primary Value: An image analytics study for an upstream operator projects that a new 360° camera reduces the cost and time to capture and process corrosion data by 90% to optimize the coating program.

Historically, facilities have used laser scanning to capture the amount of corrosion on their assets. While traditional laser scanning is able to identify large sections of corrosion, the process of gathering and analyzing these images is often slow and tedious. Additionally, this approach requires expensive hardware and significant data storage capacity and is difficult to use on assets with limited accessibility. Further, because the data gathered from laser scanning can be hard to process and evergreen, this methodology can make it difficult for facilities to manage changes in the condition of their assets in real-time.

One recent advancement in image analytics that has a profound impact on the way facilities capture corrosion is the development of smaller 360° cameras. These new handheld cameras are capable of capturing five times more density for images and videos and can process these images more quickly than the traditional laser scanning process. With these new cameras, operators can reduce the cost and number of resources needed to capture and analyze this data.

Upstream operators can especially benefit from the 360° cameras. The upstream industry typically contributes 80-90% of process leaks to external corrosion and/or environmental degradation. In many cases, the external corrosion found on platforms is caused by coatings that have failed. These cameras allow operators to better quantify the severity of the external corrosion on areas of the platform where coatings have failed or have not been maintained well. Additionally, operators can equip current personnel with these cameras, allowing them to allocate the number of people on board (POB) to other critical personnel. As a result, operators will have quicker access to the information they need to drive decisions that will minimize future corrosion.

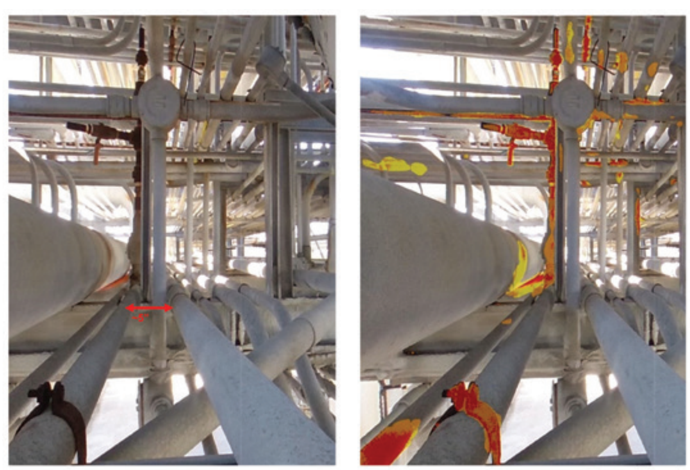

Figure 1. In a separate study, the 360° camera identified corrosion on a hot hydrocarbon line that would likely not have been detected using conventional laser technology.

Comparison Elements		
Hardware Type	Laser	360 Camera
Cost	$100,000	$1,000
Time/Scan	2.5 min	10 FPS
Processing Time	Weeks->Months	Hours
Data Size	TBs (~1 GB/scan)	GBs (10MB/scan)
Density of Scans	~6ft apart	<1ft apart
Personnel Requirements	Specialized Contractor	Facility Personnel
Accessibility	Moderate - Limited by a tripod and weight of scanner	High - Small form factor and lightweight
Time per Deck	Days	Hours
Ability to Evergreen	Low - High effort and cost to Evergreen	High - Low effort and cost to Evergreen
Cost	**$300,000 - $500,000 / platform**	**$30,000-$50,000/platform**

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Table 1. Comparison of Laser Scanning and 360° Camera for an Upstream Operator

In one use case, an upstream operator detected that over 95% of the external leaks on its offshore platforms were caused by external corrosion. While these platforms were only built about 20 years ago, the operator did not properly maintain the platforms' coating programs. The platforms need to be repainted to protect against future corrosion. However, the painting process would require the operator to add additional resources to its POB. Since painters are not often considered critical personnel, the operator has a difficult time justifying these resources. In addition to needing to repair the platforms' current coating, the operator wanted a solution that would detect coating failure before further external corrosion occurred.

The operator currently leverages laser scanning to detect and quantify external corrosion. However, with the development of the 360° cameras, this operator can train any of its crew members scheduled to be on board to use this camera, thus eliminating the need to account for these resources as part of its POB and allowing the operator to evergreen its data more frequently.

Additionally, when compared to traditional laser scanning, the cost of the equipment and time required to complete imaging for the entire platform using 360° cameras are significantly less than laser scanning. **Table 1** highlights an example of how the two methodologies compare for an upstream operator:

The differentiated image analytics study for this upstream operator projects that 360° cameras will help the operator reduce the required storage and overall cost and time to capture and process data by 90%. Additionally, the operator will be able to detect coating failures more proactively, analyze its data monthly instead of annually, and change detection over time. Ultimately, the operator will be able to optimize its coating program and shift to a more proactive approach to corrosion management.

Corrosion Study for Midstream and Downstream Facilities

Primary Value: An image analytics proof of concept (POC) showed that a machine learning model could be trained to detect external corrosion more systematically and reduce inspection time by 50%. Additionally, this model minimizes human subjectivity in inspections and creates consistency in both coating and inspection grading.

Recent advancements in image analytics can also be used to optimize inspection planning for facilities with limited staff and budgets. For example, an image analytics POC project was recently piloted at two midstream and downstream facilities. These facilities struggled with two primary challenges. First, these facilities had a limited number of staff available to perform external visual inspections. Second, the leadership of these facilities worried that many of the inspections were subject to human bias and prone to error. For example, one of the facility's inspectors may rate a coating as needing repair while another may rate the coating as not needing additional action.

To address these challenges, these facilities sought a solution that would remove the human subjectivity from inspections and create consistency in both coating and inspection grading. The solution needed to enable the facilities' inspectors with the tools they required to complete external inspections quicker, without compromising quality.

The solution comprised a five-step workflow that required building computer vision algorithms to investigate how panoramic or 360-degree handheld images with corrosion labels could be used to train a machine learning model to automatically detect corrosion and calculate the percentage of corrosion coverage based on an object's image. With these results, facilities can accurately capture the external condition of multiple assets.

This solution identifies areas of interest by creating a heat map that leverages the associated image taken by the camera with the asset's GPS coordinates to provide a graph percentage of the level of damage that exists. In addition to capturing the level of damage for the specific asset being inspected, the cameras and computers capture the damage of other assets within the same frame.

Figure 2. Image Analytics POC Workflow.

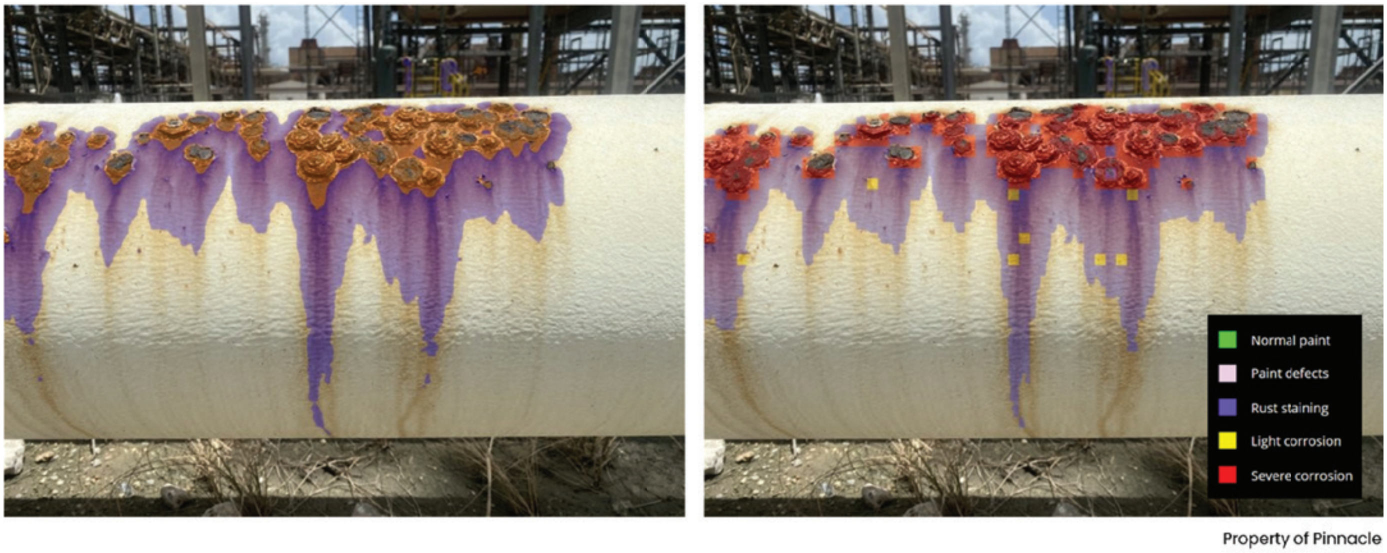

Figure 3. Example of Corrosion Segmentation Results.

Inspectors can capture multiple assets simultaneously and perform a basic screening in one click. From there, an SME can evaluate it to pinpoint precisely what assets need additional attention. Additionally, depending on the size of the facility, screening can be conducted on an entire plant in just a matter of days. Personnel can capture the images in just a fraction of the time it would take to do planned inspections. This methodology can also be used to screen hard-to-reach areas with ease, such as pipe racks and high-temperature assets that would normally require shutdown or scaffolding to be built.

The preliminary corrosion segmentation and surface texture classification results of this POC show that machine-segmented images agreed with human annotations over 75% of the time, even with limited training data.

Example of Corrosion Segmentation Results

While a single machine learning approach on its own will not fully replace ultrasound scanners to estimate the depth of corrosion that exists on an asset, texture analysis can be used to prioritize zones and areas of more severe corrosion. It's important to note that input information for processing is limited by what, how, and in which conditions the image was captured. The perspective of the SME will play a decisive role in the results when reviewing the images for shadows, excessive illumination, occlusions, and other distortions that could also impact the results. However, this image analytics POC demonstrates a possibility of a new, faster, and less expensive way to capture external corrosion while also minimizing the human subjectivity from inspections.

Conclusion

Recent advancements in visual data capture and image analytics are proving to be effective tools in helping facilities upgrade their approach to corrosion management. By reducing the cost of capturing and analyzing visual data, reliability and integrity leaders are now empowered with the information they need to make better and faster reliability decisions. ■

For more information on this subject or the author, please email us at inquiries@inspectioneering.com.

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CONTRIBUTING AUTHOR

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Siddharth Sanghavi is currently a product manager at Pinnacle. Siddharth has experience developing semi-quantitative RBI methodology and software configuration documents as well as developing quality control measures to implement Inspection Database Management System/Risk Based Inspection (IDMS/RBI) data management projects. Siddharth is API 580 and API 570 certified and obtained his Bachelor of Science degree from the University of Texas at Austin in Aerospace Engineering.

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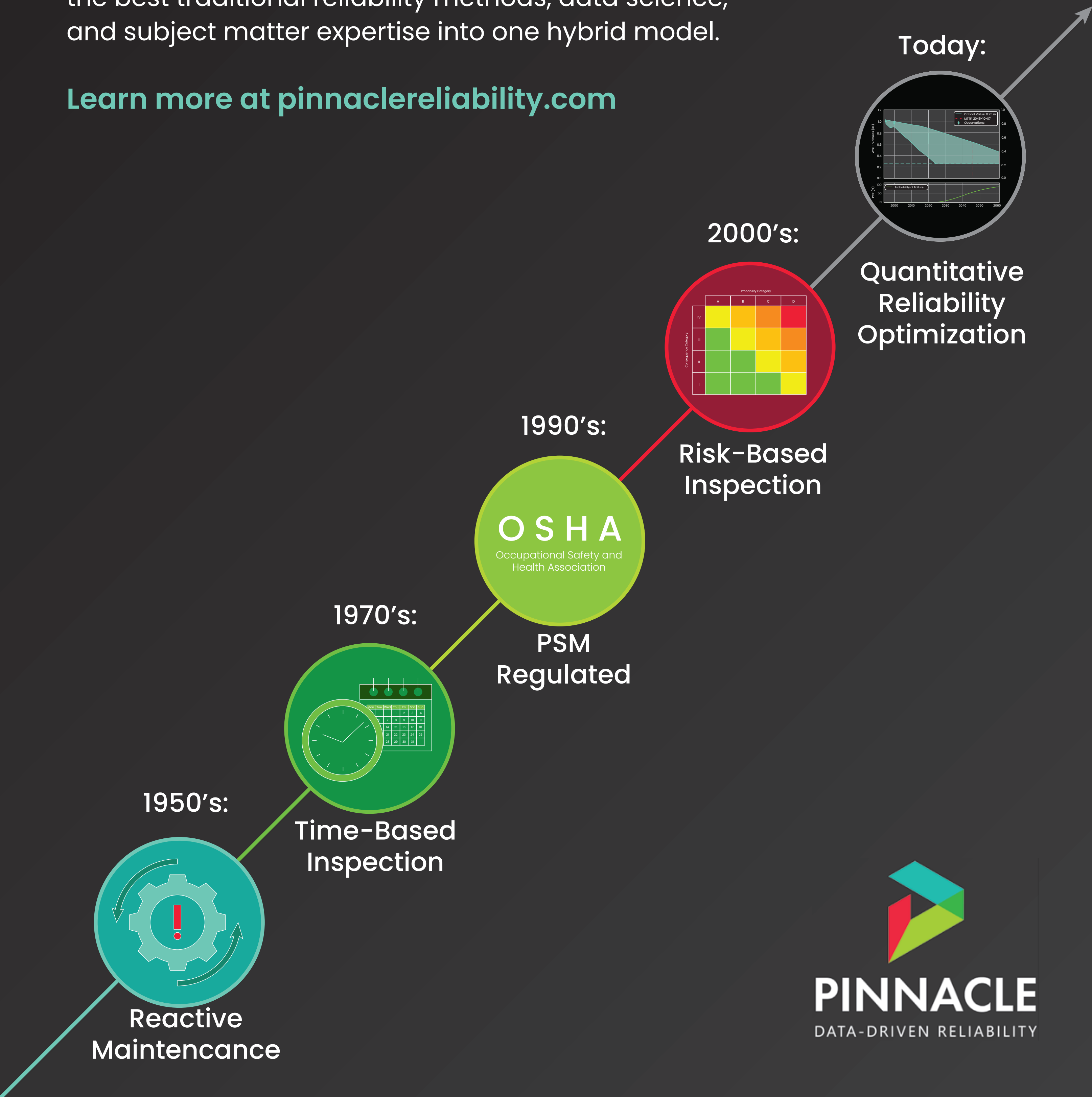

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