MACHINE LEARNING TO PREDICT THE OCCURENCE OF GALLING IN OCTG CONNECTIONS USING INFRARED IMAGES

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As the oil and gas industry continues to seek gains in efficiency and well integrity, the reliable detection of galling during the make-up process of premium tubular connections remains an active challenge. The friction between pin and box seals under high metal-to-metal contact pressures eventually cause galling and, in worst cases, the seizure of the metal surfaces. Galled internal surfaces significantly reduce the sealing of premium connections, which brings safety issues and economic penalties as well. There is therefore a desire to implement a reliable real-time galling detection toolkit based on machine learning.

In routine operations, the torque as a function of the number of revolutions (torque-turns) of the connection pin, collected from sensors embedded into the assembly machinery (power tong), is analysed by the operations technician in order to diagnose an eventually faulty assembly. A first successful attempt to analyse these torque-turns curves using machine learning was recently presented, see [1].

The paper presents a complementary approach based on thermal maps collected with infrared (IR) cameras positioned around the power tong, see Figure 1. The transition from torque-turn based 1D curves to a much more complex 2D up to 3D representation space along with the small number of samples due to the limited number of experiments are major challenges. On the one hand, we mitigate the dimensionality of representation issue by setting up a Proper Orthogonal Decomposition representation of the IR images at the price of a reasonable loss of information. Furthermore, a careful filtering of outliers images, combined with a probabilistic support vector machine decision algorithm, from our home-made optimisation and machine learning platform Minamo [2], resulted in a considerable gain in reliability of galling prediction.

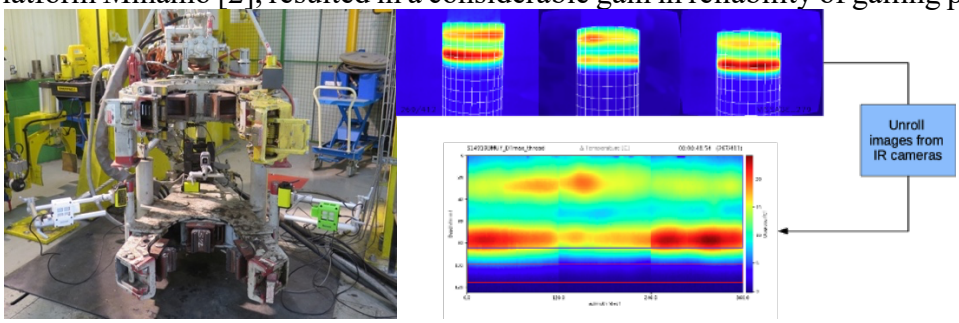

Figure 1: *Experimental setup dedicated to OCTG investigations in the VRCC with three infrared cameras (left) and the reconstructed connection temperature map (right), from the three cameras.*

References

[1] Domec, B., Machine learning streamlines tubular connection analysis, 2018, Oil & gas engineering - Magazines and Newsletters

[2] Sainvitu, C., Iliopoulou, V., & Lepot, I. (2010). Global optimization with expensive functions-Sample turbomachinery design application. Springer, Berlin, Heidelberg.