Infrared and Visual Fusion Detection Framework for Oil and Gas Pipeline Environmental Inspection

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The inspection of oil and gas pipeline retains important. These newly constructed pipelines may have defects near the circumferential welds and potential issues with water accumulation. Improper management of these issues can lead to severe consequences. Thus, the inner pipe structure detection prior to their operation is critically essential. Visual camera provides a direct view of the pipeline environment such as circumferential weld seams and water accumulation. In contrast, infrared thermal camera capture infrared radiation distribution from varied shapes and materials, offering an indirect insight into the pipeline environment. This paper designs an integrated infrared and visual NDT system for pipeline detection, capable of capturing time-synchronized infrared and visible image pairs along with corresponding odometer and gyroscope data for further processing. Moreover, an infrared and visual fusion detection algorithm is proposed, comprising coarse registration, base detectors, and probability-based late fusion strategy. The late fusion strategy enhances detection accuracy by leveraging the complementary information from both infrared and visual modalities. Furthermore, as the focus is primarily on the defects near the circumferential welds, the size of the circumferential welds in forward images can be used to predict their position in the circumferential visual detection system, achieving a 96.7% reduction in computational complexity compared to processing all images. The proposed system and algorithm were actually tested in a 26.8 km 1219 pipeline. The results verified the reliability of the system and the robustness and accuracy of the algorithm. The demo code is available at: [https://github.com/ljcuestc/Probability-based-late-fusion.git].