Computer Vision Approach for Pipeline Slug Flow Analysis

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ABSTRACT

In recent years, there has been a growing interest in understanding the impact of internal, two-phase flow-induced vibration (FIV) on the fatigue life of pipelines, particularly within the oil and gas industry. The complex interactions between gas and liquid within pipelines can lead to the formation of slug flow. Slug flow refers to significant periodic changes in gas or liquid volumes within pipeline sections, resulting in pressure fluctuations that induce flow-induced vibration. Accurately modeling slug loading is of utmost importance to ensure the integrity of both onshore and offshore flow lines and to prevent potential environmental catastrophes. This study aims to provide a comprehensive dataset that supports the evaluation of current design and analysis methodologies, as well as numerical tools commonly used in industry.

To gain a deeper understanding of the complex nature of slug flow and its impact on the structural response of pipelines, the University of Tulsa conducted a series of experimental tests. The aim was to replicate real-world pipeline behavior under slug flow conditions. In this study, we will discuss a novel in-house image-processing technique that was implemented to extract data on the coupled interaction between the internal two-phase flow and the structural response. This technique employed binary square fiducial markers for tracking the pipe response and color segmentation to distinguish the gas-liquid interface. To validate the methodology, the resulting data, including volume fraction measurements, were compared with traditional conductance probe measurements. Furthermore, we will thoroughly examine the benefits and limitations of the computer vision methodology in contrast to traditional experimental recording systems.