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Investigating the Sloshing Characteristics of a Liquid by Using an Image Processing Method

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Abstract : This study puts forward a method to analyze the sloshing characteristics of liquid in a tuned sloshing absorber system by using image processing tools. Tuned sloshing vibration absorbers have recently attracted researchers' attention as a seismic load damper in constructions due to its practical and logistical convenience. The absorber is liquid which sloshes and applies a force in opposite phase to the motion of structure. Experimentally characterization of the sloshing behavior can be utilized as means of verifying the results of numerical analysis. It can also be used to identify the accuracy of assumptions related to the motion of the liquid. There are extensive theoretical and experimental studies in the literature related to the dynamical and structural behavior of tuned sloshing dampers. In most of these works there are efforts to estimate the sloshing behavior of the liquid such as free surface motion and total force applied by liquid to the wall of container. For these purposes the use of sensors such as load cells and ultrasonic sensors are prevalent in experimental works. Load cells are only capable of measuring the force and requires conducting tests both with and without liquid to obtain pure sloshing force. Ultrasonic level sensors give point-wise measurements and hence they are not applicable to measure the whole free surface motion. Furthermore, in the case of liquid splashing it may give incorrect data. In this work a method for evaluating the sloshing wave height by using camera records and image processing techniques is presented. In this method the motion of the liquid and its container, made of a transparent material, is recorded by a high speed camera which is aligned to the free surface of the liquid. The video captured by the camera is processed frame by frame by using MATLAB Image Processing toolbox. The process starts with cropping the desired region. By recognizing the regions containing liquid and eliminating noise and liquid splashing, the final picture depicting the free surface of liquid is achieved. This picture then is used to obtain the height of the liquid through the length of container. This process is verified by ultrasonic sensors that measured fluid height on the surface of liquid.

Keywords : fluid structure interaction, image processing, sloshing, tuned liquid damper
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