סמינריון

הנך מוזמן/ת להרצאה סמינריונית של הפקולטה להנדסת מכונות שתתקיים ביום ה' 11.02.21 (כ"ט בשבט, תשפ"א), בשעה 13:45 באמצעות הזום :

https://technion.zoom.us/j/99335735201

מרצה: אדוה חזן

מנחה: פרופ' פנחס בר-יוסף.

על הנושא:

Experimental Analysis on Liquid Sloshing in Rectangular Containers

The seminar will be given in Hebrew

תקציר ההרצאה :

sloshing in containers is important in a wide range of engineering applications. For example, . Liquid it can cause a loss of structural and dynamic stability in fuel tanks, and an ecological disaster due to a structural failure in tanks that store toxic liquids. Investigation of the characteristic flow regimes: planar and / or swirling, as well as chaotic, and distinguishing their limits as a function of the characteristic parameters of the problem are of both academic and engineering interest.

The phenomenon is controlled by the viscosity of the fluid, the ratio between the initial fluid level and the dimensions of the tank, the ratio between the excitation frequency and the natural frequency, the amplitude and direction of excitation, and the shape of the tank.

The objectives of the study are to develop an experimental approach that will allow for simple and inexpensive means to characterize the flow regimes and measure the history of the liquid surface during sloshing in containers with rectangular and round cross-sectional shapes. Experimental results are validated by comparison with computational results for an ideal flow.

Fluid level is an essential measure when comparing experimental and computational results. Thus, a high total accuracy of the free surface level measurement is essential. However, the required experimental equipment can be expensive. Conventional methods typically sample fixed points on the tank, and the complexity of the rapidly changing surface of an advancing wave remains obscure. To simplify the system and reduce costs, experiments were filmed using a fast camera, and the measurement was based on an image processing method. This method enables continuous tracking of the motion of the free surface of the fluid along the tank instead of in solitary points. In the present study, a series of experiments were conducted using tanks with a rectangular cross-section subjected to horizontal harmonic excitation. The fluid level ratio was kept constant, and the frequency and amplitude of excitation were varied. The camera was placed in front of the container, and two floodlights were placed on both sides of the tank. In addition, the fluid was colored to create a sufficient contrast for image processing. The free surface was identified from the grayscale images by activation of threshold values rendered the intensity to binary values, dividing the image into segments. A square structure

element 4x4 with value of one was used to clear noise areas (spots) from the photo. Finally, the profile of the free surface is continuously measured during an experiment which lasts 250 seconds. Experimental results showed a qualitative agreement of the flow regimes with results of other studies, and also a quantitative agreement for the transition stage. In addition, signal decomposition was performed by the Hilbert and Fourier transforms, demonstrating that the frequency spectrum corresponded with computational and experimental results published in the scientific literature. The study presents a method based on the threshold method. On the one hand, the results show that the free surface was indeed identified in most of the images. On the other hand, the segmentation method is not successful in all the images. For example, in cases where the wave broke or when parts of the free liquid surface were not evenly illuminated. Nevertheless, in images which a good level-division has been obtained, it was possible to learn about the optimal operating conditions, e.g., when the excitation amplitude is small and the excitation frequency is equal to the resonant frequency. Another method of dividing the image into sections along the free surface is by identifying contours. This method was also applied in the study and a quantitative comparison between the two methods enabled obtaining results even for cases where the first method lacked.

The suggested image processing method allows us to measure the full profile of the free surface during its motion, a significant advantage compared to other techniques. In this work, each pixel was calculated to correspond to approximately 0.35 mm. The accuracy of the obtained results can be improved by purchasing an expensive camera with a higher resolution. It is further proposed to expand the current study for cylindrical containers when, due to the curvature of the container shell, the working method will be performed differently: the camera will photograph the surface of the fluid from above and the lighting will be produced at the base of the container. Before starting the experiment, the fluid depth is calibrated against the gray levels of its surface area. After this calibration, it will be possible to sample intensities from the surface to determine its height according to the calibrated gray levels.

בברכה,

שיוש"ת אתי סאס

מרכז הסמינרים