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# Can Convolutional Neural Network Improve the Discharge Measurement using Particle Image Velocimetry Method?

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The discharge of river is the most important information in the water resource management. One of the non-contact measurement techniques stemmed from Particle Image Velocimetry (PIV) is widely used in measuring the surface flow velocity and estimating the discharge in the open channel flow. The image processing method of it is conventionally based on the direct cross-correlation algorithm (DCC) considering the correlation of pixel intensity in the interrogation area as the characteristic. DCC has been proved in the laboratory; however, the conditions (such as illumination, seeding, etc.) are usually complex and not controllable in the field. These unfavorable factors not only impact on the intensity patterns of the images, but also magnify the error in matching the interrogation area and calculating the surface velocities. Applying the intensity as the only matching feature is not reliable in the field. In terms of discharge measurement in the field, a solid method which considers more geometric characteristics for the image matching is necessary.
The deep-learning model, Convolutional Neural Network (CNN), is one of the main categories to do image recognition and object detection in neural networks. With those advantages, CNN should take more characteristics on river surface into account, and build an appropriate deep-learning network structure to extract and classify the features from the river surface. Two scenarios were designed to validate the applicability of this method. One with high-density small particles and the other with low-density big particles were conducted to simulate the common circumstances of applying PIV method in the laboratory and the field. Both image sets with different seeding conditions were generated by using PIVlab. The particles on images were all based on the function of Lamb-Oseen vortex rings, thus the true values of velocity field were controlled as the benchmarks. Moreover, to quantify the quality of the results, the vector correlation coefficient which can calculate the correlation between two velocity field, was conducted to compare the results of different velocity fields calculated by CNN and DCC. The correlation value of CNN on the set of high-density small particles was 1.95, which performed similarly to DCC method with 1.98. The result of images with low-density big particles is 1.85, which is better than 1.77 from DCC. Applying the CNN can make more stable preference for different cases. It also provides better results on the angle and magnitude of velocity field. CNN, therefore, can improve the performance and stability of using PIV on the field.