Deep learning semantic segmentation for water level estimation using surveillance camera

ABSTRACT

The interest in visual-based surveillance systems, especially in natural disaster applications, such as flood detection and monitoring, has increased due to the blooming of surveillance technology. In this work, semantic segmentation based on convolutional neural networks (CNN) was proposed to identify water regions from the surveillance images. This work presented two well-established deep learning algorithms, DeepLabv3+ and SegNet networks, and evaluated their performances using several evaluation metrics. Overall, both networks attained high accuracy when compared to the measurement data but the DeepLabv3+ network performed better than the SegNet network, achieving over 90% for overall accuracy and IoU metrics, and around 80% for boundary F1 score (BF score), respectively. When predicting new images using both trained networks, the results show that both networks successfully distinguished water regions from the background but the outputs from DeepLabv3+ were more accurate than the results from the SegNet network. Therefore, the DeepLabv3+ network was used for practical application using a set of images captured at five consecutive days in the study area. The segmentation result and water level markers extracted from light detection and ranging (LiDAR) data were overlaid to estimate river water levels and observe the water fluctuation. River water levels were predicted based on the elevation from the predefined markers. The proposed water level framework was evaluated according to Spearman's rank-order correlation coefficient. The correlation coefficient was 0.91, which indicates a strong relationship between the estimated water level and observed water level. Based on these findings, it can be concluded that the proposed approach has high potential as an alternative monitoring system that offers water region information and water level estimation for flood management and related activities.

Keyword: Flood detection; Deep learning; Water level estimation; Water segmentation; CCTV; CNN