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OBSERVATION OF OCEAN WAVE BASED ON BINOCULAR VISION IN THE SWASH ZONE OF YAZHOU BAY

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ABSTRACT

Due to climate change, extreme weather events frequently occur. This can increase the probability of typhoon, resulting in storm surge more frequently. Meanwhile, the severe movement of ocean wave is generated. Ocean wave on the coastal zone can results in retreat of the coastlines and erosion for the beach. The research on the ocean wave in storm surge process based on field observation is not only able to provide the basic data for the validation of numerical model of storm surges but also significant to prevent the loss of beaches resources in the extreme climate condition. The previous studies of swash zone using video technology concentrated on experimental scale (De Vries et al., 2011), and the research parameters mostly focused on bed and water level (Wanek et al., 2006), while there is a lack of the research of ocean wave parameters. The binocular vision observation system, which mainly consists of two cameras, has been a powerful technical support in acquiring 3D information of ocean wave. Compared with the measurement of manual, radar (Harry et al., 2018) and satellite remote, the binocular vision method is not only hardly affected by weather condition, but also can acquire the continuous image data. In addition, two cameras with high resolution can obtain high precision measurement results. This study aims at obtaining the wave height of the swash zone in storm surge process.

The binocular vision technology is to observe the same object from two different viewpoints such as left and right to obtain image pairs, and to obtain three-dimensional spatial coordinate of the object point by calculating the positional deviation between image pixels through triangulation principle. In the study, the binocular vision method is based on the theory of Direct Linear Transform (DLT) developed by (Abdel-Aziz and Karara, 1971). To establish the direct linear relationship between the object point (X, Y, Z) in three-dimensional world coordinate system and imaging point (x, y) in two-dimensional image coordinate system is the main purpose of DLT theory. The three-dimensional object coordinate is determined by two images from differing perspectives such as left and right. Each image point can establish two equations, giving a total of four equations. Therefore, the matching of the corresponding left image points (x_L, y_L) of in the right images (x_R, y_R) is essential. In this study, we use the novel method for local image feature matching (Sun et al., 2021). In addition, since the radial distortion is the main source of error and can not be ignored, (Abdel-Aziz and Karara, 1974) this study simplifies the process of optical distortion correction, mainly considering the image deformation caused by radial distortion and eliminating it (Zhang, 2000).

In sum, the key process of binocular vision technology mainly involves two steps. The first step is the calibration of the left and right camera respectively to eliminate the radial distortion and establish the DLT relationship. Image matching of a point on left image to a corresponding point on right image is the second step. After this, the calibration result of two cameras and image matching results would be used to determine three-dimensional spatial coordinates of object points.

The field experimental site selected for this study is on the Yazhou Bay, which is the southwest bay of Sanya City, Hainan Province (Wang, 2016). In this study, the wave elevation results have been validated by comparing with the data acquired by a RBR micro wave tide meter (RBRsolo3 D | wave16). The test was placed in the intertidal zone. When the tide reaches the highest level, the RBR micro wave tide meter and its supporting frame can be completely submerged, and when the tide reaches the lowest level, it is exposed on the beach. This study selects the fluctuation of the wave surface elevation during the rising tide period in 22s for verification. The result of verification is shown in Figure 1. It shows that the result calculated by binocular vision can obtain very similar profiles to the result measured by the wave tide meter.

Figure 2 shows the wave height results calculated by the binocular vision technology at one point under the impact of typhoon Talim. As is shown in Figure 2(a), several larger ocean waves are scouring against the beach, simultaneously with

many whitecaps. The result of wave height is shown in Figure 2(b). The effect of Typhoon Talim caused the more complex motion of ocean wave, so the wave height's change is bigger. According to the analysis, the maximum wave height is 0.912m, and the significant wave height is 0.78m. The severe movement of ocean wave could result in the much higher wave height in the swash zone, it will cause the loss of beach resources.

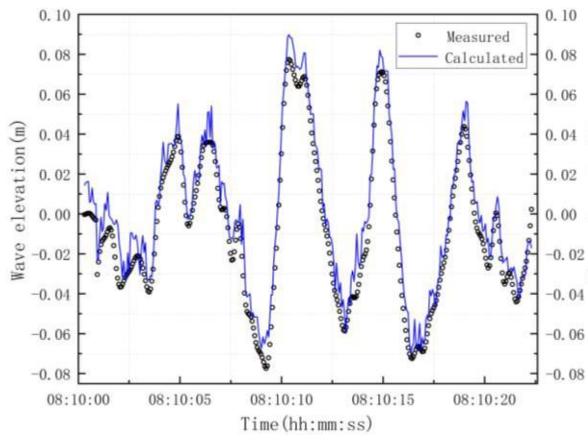

Figure 1. A 22s comparison of the calculated and measured data. The blue solid line indicates the data calculated by binocular camera and the black hollow dots represents the measured data extracted at the location of the RBR micro wave tide meter.

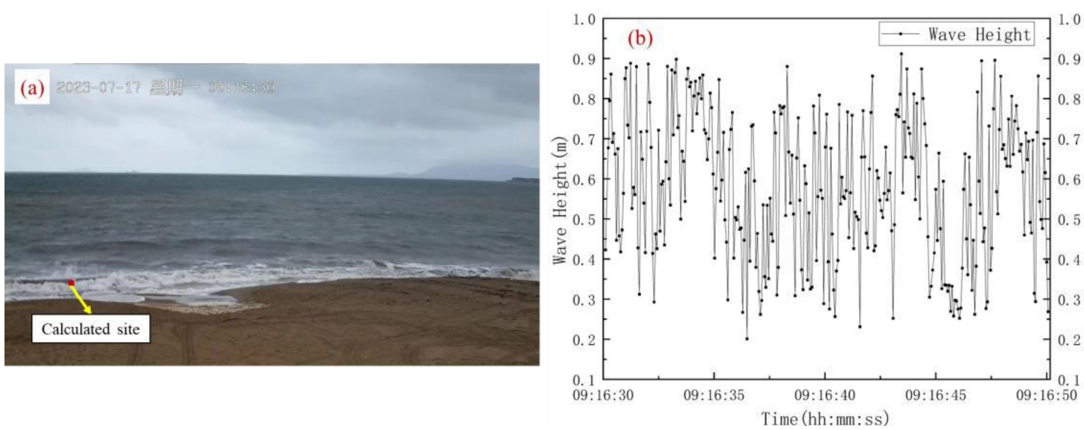

Figure 2. Wave height calculated by the binocular vision technology at one point under the impact of Typhoon Talim: (a) the observation area and calculated site; (b) the variation of the wave height

In conclusion, the binocular vision observation system is proved to be a suitable tool to observe the ocean wave. In general, the system can capture the wave elevation in the motion of ocean wave, almost similar to actual measurements.

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