Evaluation of water depth and wave propagation characteristics by using aerial image sensing and infrared laser scanning （空中撮像と赤外線レーザー走査を用いた水深と波浪伝播特性の評価）

［課程博士・論文博士共通］

博士学位論文内容要旨
Abstract

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Water depth evaluation keeps an important role in coastal protection and management. Recently, the ultra-sonic sounding ship survey is used as the standard method. However, it is difficult to apply this method to shallow and narrow sea area where it is difficult for ships to navigate. The Airborne lidar bathymetry (ALB) has recently attracted attention because it can simultaneously survey land and water areas in a short time. However, it is known that the absence of measurement may occur when the turbidity of water is large.

In this study, we developed a method to compensate for the water depth based on the dispersion relationship from the propagation characteristics of water surface waves. The output of an aerial photogrammetry camera and a near-infrared laser scanner attached to the ALB system was used to know the wave propagation characteristics.

First, the use of successive vertical sill images from a photogrammetry camera mounted on a moving helicopter was discussed. A series of ortho-images obtained from a photogrammetry camera was extracted, a long-component wave image was prepared by applying a 2D Fourier transform and a low-pass filter, and wavelength and wave celerity were obtained by a lag correlation method.

Second, use of laser scanner mounted on a moving helicopter was discussed. In laser scanner data, simultaneous wave profile data on the elliptic circle of laser beam trace were prepared by applying a spatial-temporal binning method, and the wave propagation direction and wavelength were obtained.

From the propagation characteristics of these waves, the water depth was estimated from the dispersion relationship. As a result of applying it to the data acquired in the Niigata coast, it was found out that in the shallow sea area, though the water depth could be analyzed with high accuracy, the measurement accuracy greatly lowered as the water depth deepened. It is also found that, on the observation day, water depth evalution at North-East area could be evaluated, while water depth evaluation at South-West did not get a good result. This problem came from the effects of the sunlight.

Although the image sensing can evaluate the water depth, it is known that the absence of measurement occurs when image quality is strongly affected by sun glitter. So, the method to investigate the wave propagation by using the oblique aerial video images taken from a UAV held in a fixed point was developed. Ortho-images were created from video frames by using the collinearity equation and perspective transform. Time-averaged images were created by the average of frames during the time after that the grayscale images were calculated. The relationship between the time-averaged grayscale image and light environment was investigated by considering the reflection properties of the sea surface and the radiance distribution of incident light. This model emphasized the best observation angle. Under the conditions of this study, it was found that when the camera was tilted with the off-nadir angle of about 60 degrees and photographed in the forward light, the effect of the sun glitter was well suppressed. The significant wave period and the wave celerity can be

evaluated from the time history of the gray-scale images. The wave spectrum, wave direction, and long-component wavelength were handled by using 2D Fourier transform and low-pass filter. As a result, applying the present method to data acquired in the Tateyama coast, the wave propagation characteristic was successfully evaluated.