ビデオ画像を利用した浅海域における水深と波浪スペクトルの推定法に関する研究

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論　文　要　旨

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論文題名	**DEVELOPMENT OF VIDEO IMAGE ANALYSIS METHODS FOR ESTIMATING BATHYMETRY AND THE DIRECTIONAL WAVE SPECTRUM IN SHALLOW WATER AREAS** (ビデオ画像を利用した浅海域における水深と波浪スペクトルの推定法に関する研究)		

論 文 内 容 の 要 旨

Since the first development of the video image measurement and analysis method in 1980 by Coastal Imaging Lab, Oregon State University, USA, similar methods have been developed and applied as a very convenient measurement tool for monitoring near-shore zones. Although the methods have been applied at some specific coastal areas, the methods have not been used for practical applications yet since the applicability and accuracy of the methods are still unclear. Therefore, it is of great importance to evaluate them with other field measurement data so as to be applied for practical purposes.

The objectives of this dissertation are to examine the applicability and accuracy of video image analysis methods through the following specific aims. The first aim is to examine the wave number inversion method for estimating shallow water bathymetry. The second aim is to develop a new method for estimating directional wave spectra from video image data based on the Bayesian directional wave spectrum estimation method (BDM), which was originally developed by Hashimoto (1987) for in-situ measurement using wave gauges.

This dissertation consists of seven chapters. Chapter 1 gives the background information, problem identification, and the motivation and objectives of this research. The framework of the thesis structure is also presented.

Chapter 2 presents a historical review of the development of video image measurement and analysis methods. It also describes the specification of video camera, the feature of video image, and the video image processing. The image processing involves inverse transformation method from image coordinates to real coordinates system.

Chapter 3 presents the estimation method of shallow water bathymetry using time series data of pixel brightness at an array along a cross-shore and long-shore transections in the rectified image sequences. The estimation method of shallow water bathymetry consists of the wave number inversion method, which is based on cross-spectral correlation technique (Plant et al., 2007) and the bathymetry inversion method, which is based on the wave dispersion equation. The analyzed results by the wave number inversion method showed that the method has the capability to derive wave numbers for estimating shallow water bathymetry with small root-mean-square errors especially in the area between shoreline and breaker zone.

Chapter 4 discusses the spectral analysis method applicable to the time series data of pixel brightness on video images for estimating sea surface elevation. Although the time series of pixel brightness on video images depend on not only wave slope but also other phenomena such as sea ripples, wave breaking, and sun glitter, etc., the analyzed results showed that the wave spectra estimated from video images are in good agreement with those estimated from in-situ measurements of water surface elevation. The positions of peak frequency in both wave spectra are very close to each other

Chapter 5 describes the development of a new method for estimating directional wave spectra from video images in shallow water areas based on the BDM. The method is not only accurate but also robust in estimating directional spectra since it satisfies the two requirements, i.e., the minimization of errors and the smoothness of the energy distribution with respect to direction. A star and a polygon array designs from the pixels brightness of video images are examined to improve the accuracy of directional spectral estimation. The proposed method showed that it can estimate directional spectra successfully from pixels brightness on video images in shallow water areas. Comparative study showed that the BDM provides more suitable results than the Maximum Likelihood Method (MLM) although the MLM is the most common method in the directional spectrum analysis. The energy distribution of the directional spectra estimated by the BDM showed more peaked and concentrated energy distribution at frequency and direction.

Chapter 6 compares the directional wave spectra estimated by the proposed method with the numerically simulated ones with a third generation wave model, SWAN. The SWAN can simulate directional spectra in near-shore areas with high accuracy by taking accounts of the effects of refraction, bottom friction, nonlinear interaction, wave breaking and currents. The comparative study showed that there are good agreements between directional spectra estimated by the proposed method and the ones with the SWAN, showing almost similar energy concentration in frequency and direction of the directional wave spectra

Finally, Chapter 7 presents the conclusions from the previous chapters. The major conclusion is that the examined and proposed methods for estimating bathymetry and directional wave spectra from video images are accurate enough for practical applications.