Accuracy of optical frequency comb profilometry using a single pixel camera for different frequency selections

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A remarkable effort in the fields of the ultra-stabilized optical frequency comb science has realized an optical frequency comb laser source. Especially, the link between an optical frequency and a radio frequency of the optical frequency comb laser beam has been also recognized; this has opened and expanded many new possible advantages in profilometry by several available methods. In our previous researches, an optical profilometry with a wide axial dynamic range using a frequency comb generated by an ultra-stable mode-locked femtosecond laser and a single-pixel camera with the compressive sensing (CS) technique has realized. In this system, the frequency comb laser with repetition rate of 76 MHz and a single pixel camera using fast photo-receiver with maximum response frequency of 1GHz were used. The frequency selection module (FSM) was designed to select frequency of 988MHz corresponding to frequency harmonic of 13^{th} allowed measuring the object's profile with root mean square (RMS) error of 4μm.

In this study, the different frequency harmonic orders can be selected to measure the object's profile so that the accuracy and the performance of the system were investigated by using an alternative frequency selection module (FSM). As the results, the best frequencies were chosen to obtain the object's profile with less error by two-frequency method.

The experimental system is described in Fig. 1. The object wave consisting thousands of monochromatic phase-locked wavelengths was encoded by the random mask displayed on a digital micro-mirror device (DMD) of a single pixel camera. The encoded optical wave contained the amplitude and phase information of all object points and the reference wave was focused on fast photo-receivers. A specific frequency was selected by the FSM to measure the phase. For each random mask, one phase measurement was performed. When the number of measurements qualified the reconstruction condition of CS, the relative depth information of the each point on the object surface was extracted. The experiment result shown in Fig. 2 was the RMS errors calculated from the measured profile of a plane mirror using two selected frequencies for different number of 10×10 pixels random masks. The more details of the system will be presented in our talk.

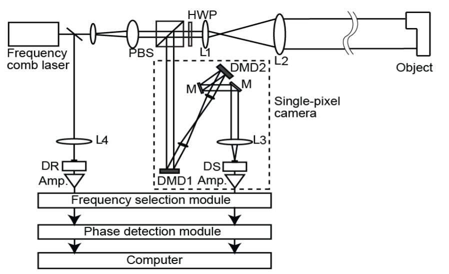

Fig. 1. Experimental setup.

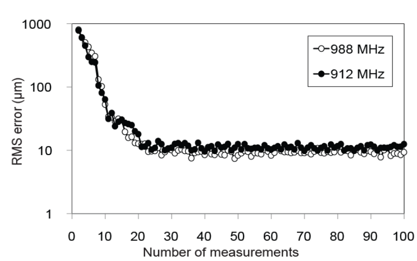

Fig. 2. Experimental results.