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Development of the 2D singleshot, long range tomography and profilometry with consideration of the rapid calculation of interference fringe order

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In the previous report[1], we presented a 2D tomography and profilometry. The system could obtain the optical dimension in depth directions of the samples whose reflectivity is relatively high. In the system, we used an optical resonator to create the optical frequency comb from a broadband light source in order to expand the measurement range of the tomography and profilometry. Interference signals which carry the sample information could be seen on a CCD camera in real time. Each interference signal has its own interference fringe order, and we have to calculate the fringe orders to derive the sample's optical dimension. In the previous report[1,2], we introduced two methods to calculate the fringe order. However, it required several technical processes, causing a time delay for the derivation of the sample information. Therefore, it was actually not a singleshot operation. In this report, we provide a technique to detect the interference fringe order in the same time with the image acquisition process so that the singleshot operation of the 2D long range tomography and profilometry become reality. Figure 1 shows a schematic of the proposed system.

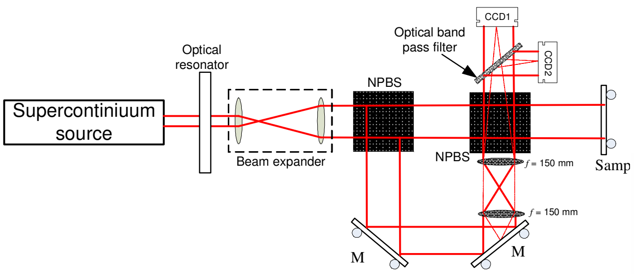

Fig.1: optical schematic of the proposed system

Optical frequency comb is generated from a super wide band supercontiniuum source and the optical resonator. The free spectral range of the comb depends on the physical thickness of the resonator and the wavelength of the light source. By choosing two different wavelength ranges of the superconiuum source, two different FSRs are generated. Once the FSRs are slightly different, the separation (D) between two adjacent interference fringe is slightly shifted (ΔD). Based on the shifted ΔD, we can derive the fringe order of the recorded interference fringe. In the proposed system, two wavelength regions can be separated by using a optical band pass filter. Each wavelength region is monitored by one CCD camera. Therefore, we need two CCD cameras to be able to calculate ΔD simultaneously. For the trial experiment, we test the ΔD by using two different broadband light sources, whose center wavelengths are different. The first light source is superluminecent (SLD, center wavelength: 1550 nm) and the second light source is supercontiniuum (SC, center wavelength: 1062 nm). The bandwidth of the SLD is 90 nm, the effective bandwidth of the SC is estimated of ~ 120 nm based on the recorded interference image. Figure 2, 3 show the optical comb spectrum generated by two light sources, in which the FSR of the SLD light is ~ 208 GHz, while the FSR of the SC light is ~ 230 GHz

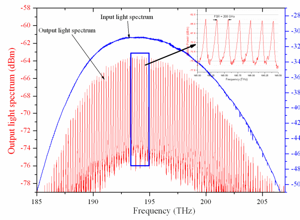

Fig.2:Optical comb generated by SLD and resonator

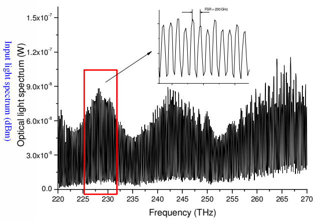

Fig.3:Optical comb generated by SLD and resonator

Figure 4,5 show the interference images of the two adjacent interference fringes whose order are k, and k+1, respectively, by SLD and SC light.

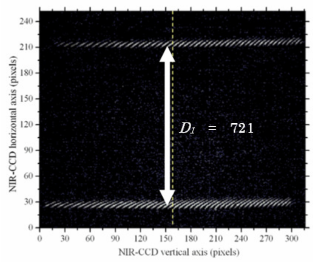

Fig.4: Two adjacent interference fringes using SLD light

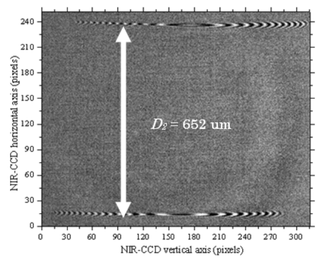

Fig.5: Two adjacent interference fringes using SC light

Based on the shift ΔD and the pre-defined lookup table for the fringe order, individual fringe orders of the observed interference fringe can be calculated effectively.

[1] T. Q. Banh, et. al., *Opt. Commun.*, Vol. 296, pp. 1-8 (2013).

[2] T. Q. Banh, et. al., Lightwave Sensing technology, LST48-26 (2011).