Penetrable three-dimensional shape measurement using continuous-wave terahertz interferometric imaging method

Hyeongyong Hwang[1], Joo-Young Lee[2], Young Ho Kim[3], Myoung Jin Kim[2]

[1]Optical Precision Measurement Research Center, Korea Photonics Technology Institute, Republic of Korea, [1]Optical Precision Measurement Research Center, Korea Photonics Technology Institute (KOPTI), Republic of Korea, [1]Optical Precision Measurement Research Center , Korea Photonics Technology Institute (KOPTI), Republic of Korea

Terahertz waves are electromagnetic waves in the frequency range of 0.1 THz and 10 THz which provide greater penetration depth than infrared waves and a better spatial resolution than microwaves. Based on the penetrable characteristics of the terahertz wave, nondestructive vision inspections have been proposed in various fields such as the food industry, building insulation materials, and biomedical applications. Here, we propose a penetrable terahertz interferometric imaging system that can reveal depth information in optically opaque objects and provide much better contrast for weakly absorbing materials. Specifically, terahertz interferometric imaging is used to measure the phase distribution via a photonic generation of dual-wavelength THz signals and self-mixing heterodyne detection. The dual-wavelength THz source we used can measure around 30 mm of depth at 0.3 THz which overcomes the 2π phase ambiguity of single-wavelength one. In addition, four-step or five-step phase-shifting algorithms are introduced to retrieve the phase map with very high accuracy and low distortion. The relative depth profiles of transparent objects are successfully extracted by using the relationship between the phase and the depth. The attained results validate that the terahertz interferometric imaging system in conjunction with the phase-shifting method allows effective reconstruction of the phase information of the object.