스트로보스코픽 ESPI를 이용한 진동측정
Vibration measurement with stroboscopic ESPI

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Electronic speckle pattern interferometry has many applications in science and engineering. Among these, vibration measurement is the area where ESPI has many advantages over other techniques. We developed a stroboscopic ESPI system to measure the harmonic vibration of a piece of copper tape attached to a circular hole structure.

Figure 1 shows the schematic diagram of the stroboscopic ESPI system. Laser light passes acousto-optic modulator and become light pulses of the same repetition rate as the speaker frequency. The modulated laser beam is divided by a beam splitter. The object beam is illuminated to a sample and the reference beam is phase-shifted by a PZT mirror. Both beams are collected onto CCD pixels.

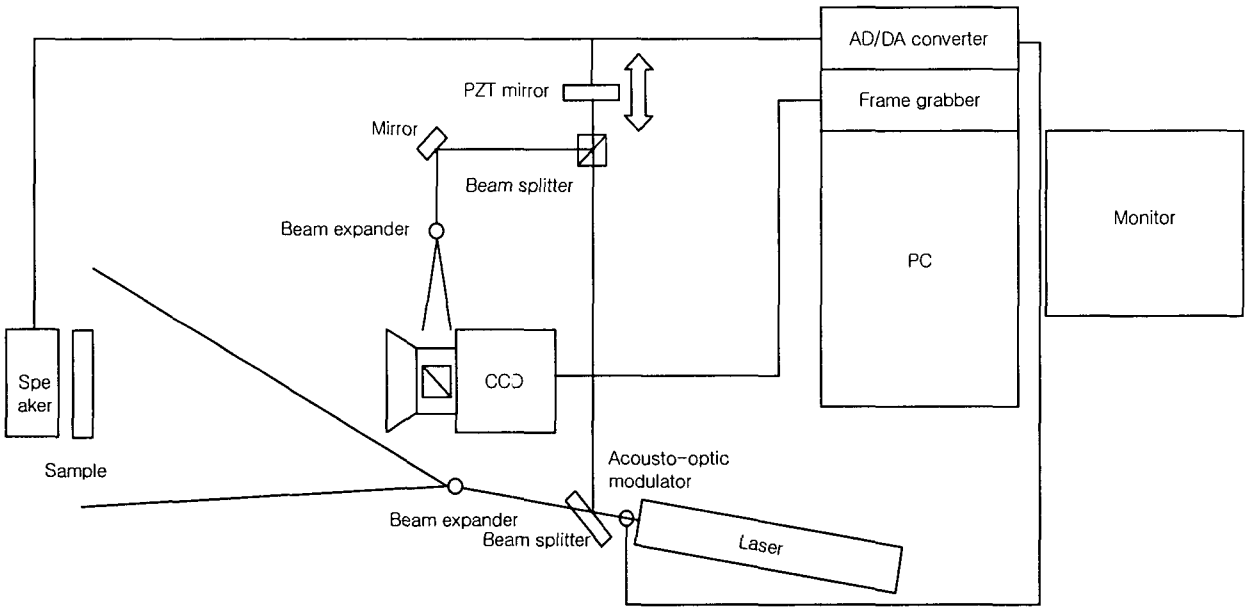

Fig. 1. Schematic diagram of the stroboscopic ESPI system

We measured a piece of copper tape attached to a circular hole structure with 3.5-cm diameter. Speaker and AOM are driven by a 820 Hz sine or pulse signal that are generated by an AD/DA converter put in a PC. Therefore we can monitor the specific state of the vibration at the moment when the light is illuminated. A large number of laser pulses are integrated into one frame to acquire enough intensity for the precise calculation. Four frames are captured in this manner with a translating PZT mirror for the four-step phase-shifting scheme. First, four frames are captured without vibration as a reference. Second, four more frames are captured with vibration. From these two sets of data, the state of vibration at the specific moment of the vibration cycle is analyzed. By controlling the relative delay between the speaker and AOM signals, we measured 12 sets of data.

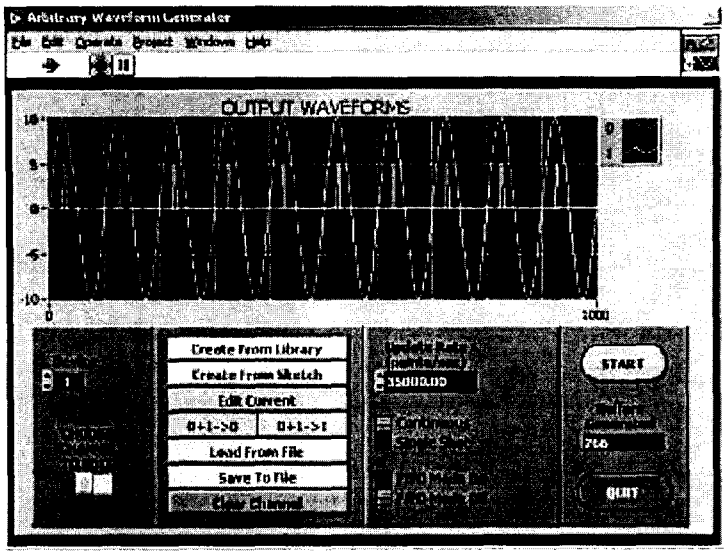

Fig. 2. Speaker and AOM signal

The filtered and unwrapped final results, presented in Fig. 3, show how the sample vibrates in one cycle. The amplitude of the vibration is about 500 nm.

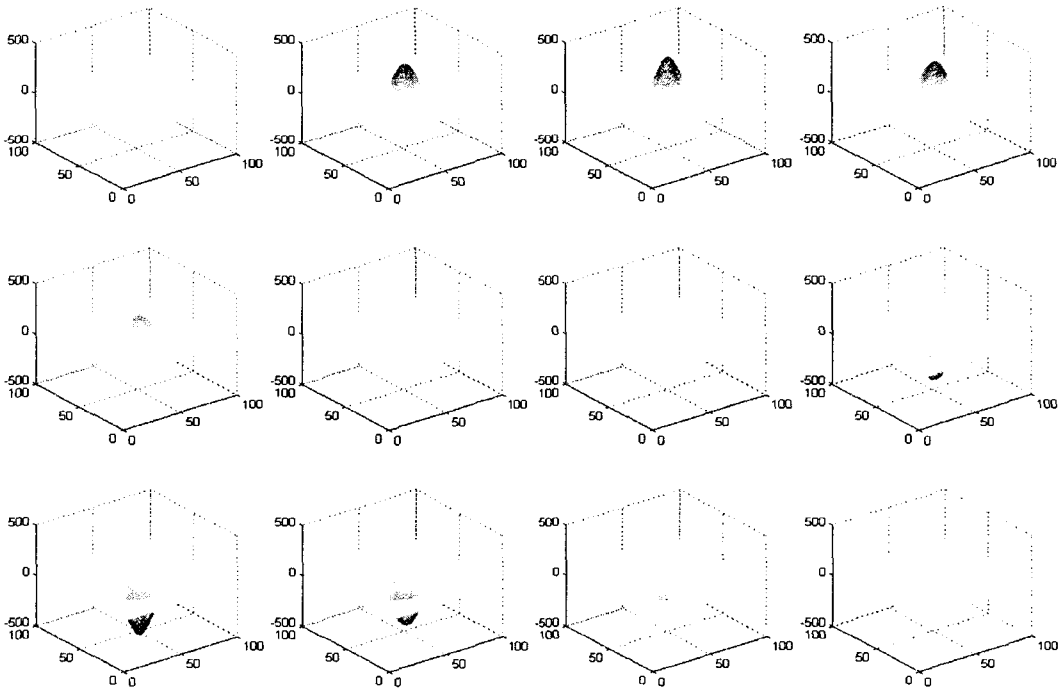

Fig. 3. Measured 1 period vibration sliced in 12 frames

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