Dynamic visible interferometric measurement of thermal emission from living systems

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Abstract: Phase information corresponding to small changes in the refractive index of air due to thermal emission from living biological objects and independent of object motion can be measured using dynamic interferometry with a visible source. We will present results comparing different objects at data rates of many frames per second.

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Dynamic interferometry is a highly sensitive means of obtaining phase information that can take phase data at rates of multiple frames per second[1]. Many techniques have been developed to take multiple frames of interferometric data simultaneously[2-4] and commercial instruments are being designed with the purpose of measuring phase data in the presence of vibration and air turbulence[5,6]. The sensitivity of these phase-measurement instruments is on the order of thousandths of a wavelength at visible wavelengths. This sensitivity enables the measurement of small temperature changes and thermal fields surrounding living biological objects.

Figure 1 shows sample measurements taken with a 4D Technology Corp. PhaseCam interferometer using a HeNe source. Temperature differences are clearly noticeable using a visible wavelength source because of subtle changes in the refractive index of air due to thermal variations. Living objects can also easily be measured over a period of time to monitor changes as a function of time. This technique has many promising applications in biological and medical sciences for studying thermal fields around living objects.

Fig. 1. Dynamic interferometric phase measurements of the field around (A) a room temperature screwdriver handle, (B) a screwdriver handle at body temperature, and (C) the tip of a finger. All images are scaled the same with background subtracted. Yellow indicates +0.05 waves OPD and dark blue indicates –0.05 waves OPD.

thermal changes in living systems
radiative... biological objects... ???