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Applications of Laser in Control of Micro deformations

There are two basic types of laser measurement systems the ranging systems and interformetric systems. In the ranging systems the elapsed time between emission and reception of laser pulses are measured. Also the ranging systems make measurements at single points, and need to make measurements at N discreet points to provide N data points. Interferometric systems provide many advantages over laser ranging systems, including higher speed, higher resolution, 3-D deflection data, and a wide variety of static and dynamic engineering mechanics measurements derived from these deflection measurements. Interferometric measurement systems can take many channels of independent measurements simultaneously with a single momentary exposure. This paper traits one interferometric method, ESPI (Electric Speckle Pattern Interferometry) and it is based on the diploma project of author, project do at IUT Bethune, France.

1. Introduction

Laser (Light Amplification by Stimulated Emission of Radiation), one of the greatest discover of the xx century have many applications in engineering. Cutting, welding, heat treatments or measurements with laser are the firsts but everyone of this are in continuous progress and new methods are discovered. The principle of a laser(figure 1) is based on two separate features a light emitting/amplifying medium and b) an optical resonator (usually defined by two parallel mirrors). Atoms and molecules have determinate energetic levels, which can be low or high. The low energetic levels can be excited at high levels, generally by heating. Once they reach the energetic superior levels, they go back to the original state and they return energy in a light form. In most cases the sources of ordinary light which comes from atoms and excited molecules and the light emission is done in various wavelengths (and frequencies). But, if during the short instant an atom is excited, the atom is influenced by light of a certain wavelength, this atom can be stimulated to launch radiation that is in phase with the wavelength that has stimulated it. The new emission amplifies the wave. Then, the resulting beam is a coherent light beam and it can be high-powered.

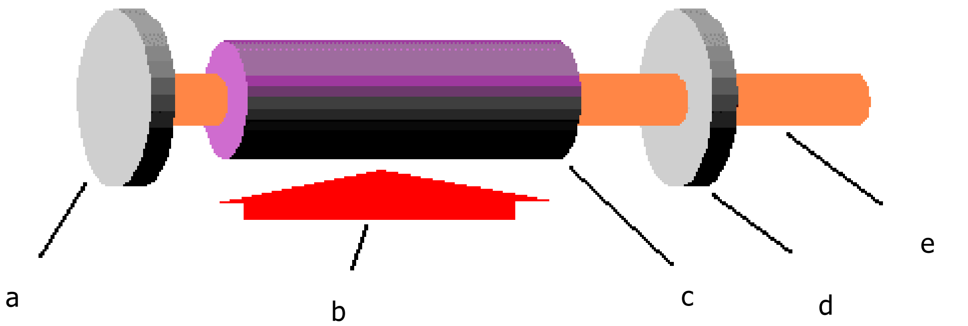


Figure 1. Laser principle [24] a- first mirror, b-excitation, c- amplifier, d-second mirror (semi-argente), e-laser beam

2. Holography and holographic interferometry

There are two basic types of laser measurement systems: ranging systems (ex: Doppler vibrometers) in which the elapsed time between emission and

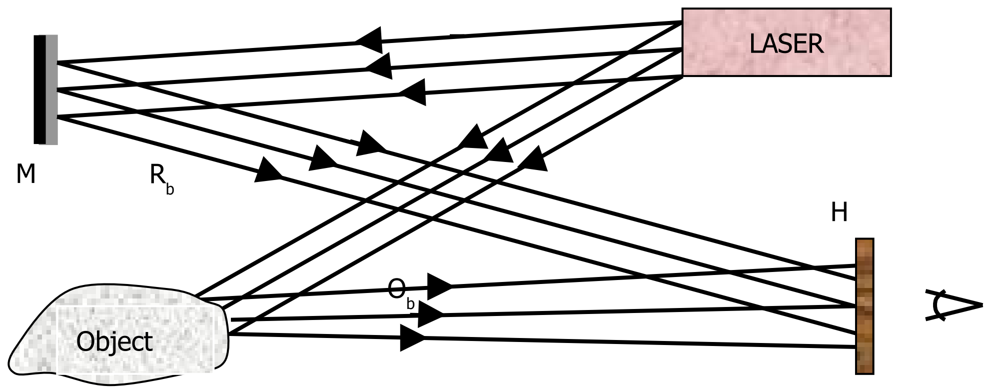


Figure 2 Hologram registration
M-mirror; R_b – reference beam; Ob- reflected (object) beam.

reception of laser are measured. This systems make measurements in a single point, and is necesarly to make measurements at many discreet points with many exposures to provide many data points results. The excitations must keep the caracteristics over the entire period of measurements to provide valid data, a requirement difficult to fulfill.[22]

The interferometric systems, the other basic type of laser measurement systems, provide many advantages over laser ranging systems, including higher

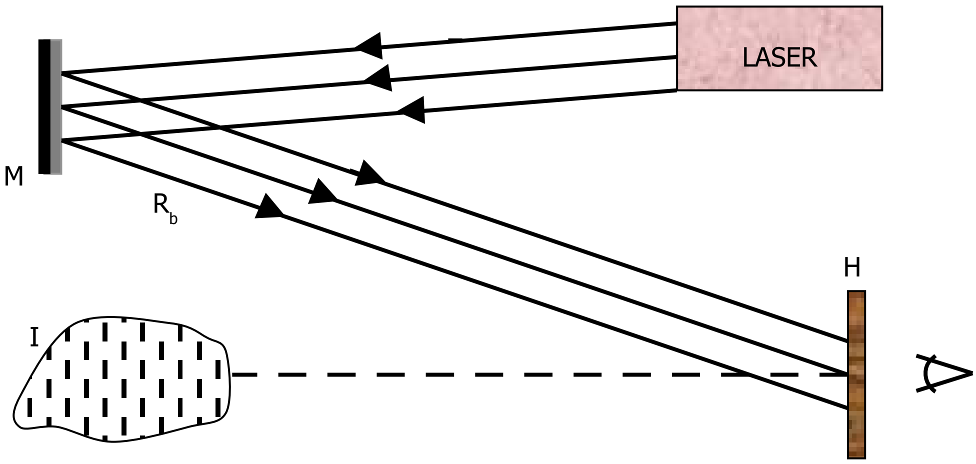


Figure 3. Hologram restitution (m-mirror)

speed, higher resolution, 3-D deflection data[22]. They upon the coherence of monochromatic properties of laser light for their measurement basis, still coherent even when defocused and projected onto large areas. Interferometric measurement systems can take many channels of independent measurements simultaneously with a single momentary exposure. One of this methods is Electronic Speckle Pattern Interferometry (ESPI).

ESPI is the next generation successor to laser holography. Like in holography (fig. 2), no scanning is required for ESPI because it uses a defocused laser to illuminate a full measurement field. After this, the reflected coherent laser light and a reference laser beam are compared at each point in an image plane (fig. 3), generating a reference speckle pattern from the mirror reflected laser light and the light reflected from the surface.

ESPI make simultaneous measurements in many thousands of independent points over the entire field of view but all data are digitized and may then be reduced to common engineering units via digital computer algorithms and this is the difference reported at holography. The ESPI interference pattern is generated on a CCD focal plane and digitized.

3. ESPI System Configuration

The configuration use in experiments is presented in figure 4. The source laser is a holocamera HLS 3 made by Lumonics Ltd.

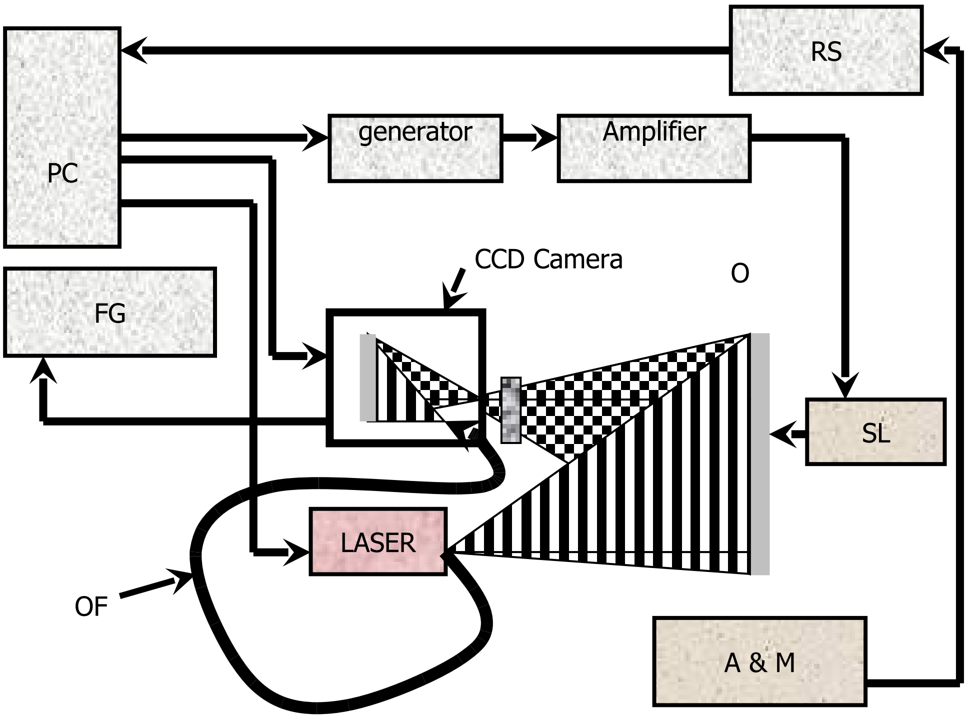
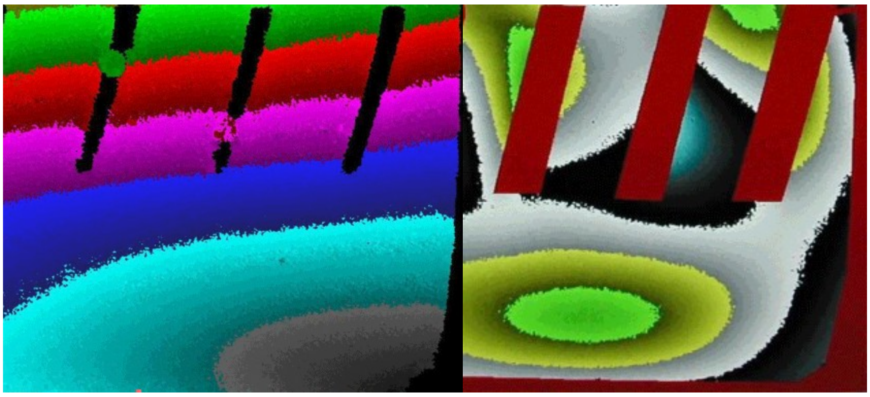


Figure 4. ESPI System [22] (RS-reference signal, O-object, A-accelerometer. M-microphone, SL-Shaker Load, FG-Frame Grabber, OF-optical fiber)

Some examples of results obtained on the experiments are presented in figure 5. In the first case the excitation is static, case b) represent a vibrating model and the on c) it is represented the scale of colors for microdeformations. Also is possible to obtain a 3D model of object using electronic speckle pattern interferometry.



a) b) c)

Figure 5. The results obtained on computer screen in a static excitation (a) a vibrating model (b) and the scale for micro-deformations (c)

4. Conclusions

Providing perfectly general measurement results with no transducer installation, ESPI technology is preferred for strain measurements in such challenging applications as edges, corners, cutouts and fillets, and for strain in discontinuous structures such as metal inserts in composite structural parts[22].

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