Faculty of Electrical Engineering & Computer Science
Master Degree Course Electronics Engineering, MSc EE

HOCHSCHULE BREMEN
UNIVERSITY OF APPLIED SCIENCES

Master 2011

Khaled Elshaffey

Investigations of the limitation of phase retrieval regarding the partially coherency light

ABSTRACT - Masterthesis

Monochromatic light can be completely defined by means of its amplitude and phase, within the scalar diffraction theorem. A Charge Coupled Device is a device which can be used to detect the intensity of a light wave. Taking the square root of the intensity the amplitude is defined. Due to its rapidly fluctuating, there is no device which can directly detect the phase of a light wave. Thus the phase problem is arisen. There are many methods to determine the phase of a wave-field. One of these methods is referred to as phase retrieval. The most established phase retrieval technique recovers the phase of a light wave from a number of intensity measurements. Luckily, phase retrieval has low demands regarding the coherence of light, since it is not based on capturing the interference pattern arising from the superposition with a reference beam. Accordingly, one can use a partially coherent source; such as LED, instead of a fully coherent source such as laser to measure the complex amplitude of a wave-field. In order to achieve this a mathematical model is formulated based on the coherent properties of the light source and the geometry of the optical setup. The model discusses the effect of using an extend source on the light generated across the observation domain. In addition, a set of limitations is defined e.g the coherent volume to guarantee the generation of a complete wave-field, defined phase and amplitude, across the observation plane. Based an this model the complex amplitude of the light diffracted by the U.S Air Force resolution test chart is experimentally determined across a remote plane. In comparison to the current phase retrieval methods which use laser, our method has lower RMS error of the reconstructed amplitude.