Abel Transform Inversion using Kalman Filter

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ABSTRACT

Refractive index, temperature, pressure, velocity and many other physical magnitudes of phase objects in the refraction less limit are of great interest in engineering and science. Optical tomography is a technique used to estimate these magnitudes. For axially symmetrical phase objects the tomographic reconstruction can be carried out from just one projection when using Abel transform. However, for noisy projections the reconstruction shows low quality. This quality can be improved when using the Kalman filter to compute the inverse Abel Transform. In this paper a tomographic reconstruction method for syntectic axially symmetrical phase objects using Kalman filter is presented.

Keywords: Kalman filter, Abel transform, phase unwrapping, interferometry.

1. INTRODUCTION

Estimation of refractive index from an interfereogram $I(x, y)$ is an important step to obtain a measure of a physical magnitude. The difficult associated to this estimation depends on the shape characteristics of the phase object been analyzed. Taking into account the symmetrical structure of a phase objects, three cases can be considered:

1. Three-dimensional phase objects with or without refractive index variations on the z axis direction.
2. Radially symmetrical phase objects
3. Radially asymmetrical phase objects

Circular symmetrical object are commonly found in flows arround cones, jets, thermal plumbers, flames, etc.,.[1,2] These phase objects can have a cylindrical or spherical shape. In both cases the refractive index depends only on the distance from the center of symmetry. The relationship between the phase object refractive index, $f(r)$, and its surrounding, n_0, is

$$f(r) = n(r) - n_0. \tag{1}$$

Figure 1 shows a ray traveling in the z axis direction through a circular symmetrical phase object, $n(r)$ and its accummulated refractive index along the ray, $g(x)$. The function $g(x)$ is obtained by tomography techniques when a phase object is penetrated by a ray (for example, X rays). From $g(x)$ a reconstruction of the internal structure of the object can be achieved. In this paper the reconstruction is carried out by using an estimate of the transfer function of Abel transform.

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