Optik 125 (2014) 667–670

Contents lists available at ScienceDirect

Optik

journal homepage: www.elsevier.de/ijleo

Analysis of the common characteristics of the Hartmann, Ronchi, and Shack–Hartmann tests

Fermín Salomón Granados-Agustín[a,*], Octavio Cardona-Núñez[a], Rufino Díaz-Uribe[b], Elizabeth Percino-Zacarías[a], Ana María Zárate-Rivera[a], Alejandro Cornejo-Rodríguez[a]

[a] Instituto Nacional de Astrofísica, Óptica y Electrónica, Calle Luis Enrique Erro No. 1, C.P. 72000 Tonantzintla, Puebla, Mexico
[b] Universidad Nacional Autónoma de México, Centro de Ciencias Aplicadas y Desarrollo Tecnológico, Circuito exterior S/N, Cd. Universitaria 04510, D.F., Mexico

ARTICLE INFO

Article history:
Received 4 March 2013
Accepted 5 July 2013

Keywords:
Aberrations
Optical testing
Wavefront sensors
Interferometers

ABSTRACT

An overview of the settings of the planes for the filters and observed patterns in the Hartmann and Ronchi tests is presented. Also a new set of filters for both test were developed. In a similar way, it is easy to extend this analysis to the Shack–Hartmann test, and to propose a new Null Shack–Hartmann filter.

1. Introduction

In the field of optical testing of optical surfaces and systems, there is a profuse quantity of techniques (Malacara [1], Twymann [2], and Dyson [3]) and they are classified as interferometric, and non-interferometric (sometimes called geometrical or curvature slopes) measurements. Some of them, like the Hartmann [4] and Ronchi [5] tests in the past were classified in the second group. But later on, they were recognized as interferometric techniques also [6]; and one important advantage of the second group mentioned above, and among them the Hartmann and Ronchi tests, is that they do not need sophisticate equipment or reference optical components, only a kind of filter that could be a knife edge [7], wire [8], Hartmann screen, or Ronchi ruling. Hence a qualitative analysis can be carried out very easily; but on the other hand, if quantitative results are required, careful mathematical treatment of the information registered in a Hartmanngram or Ronchigram can also be realized; as it usual in all the testing interferometric and non-interferometric methods.

2. The Hartmann and Ronchi tests

The Hartmann and Ronchi tests were discovered at the beginning of XIX Century. For many years they were analyzed in different

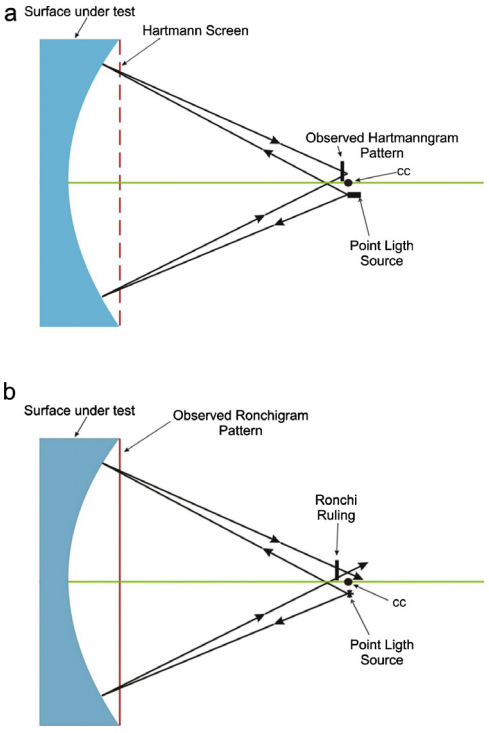


Fig. 1. Diagrams for the experimental schemes for: (a) the Hartmann test, and (b) the Ronchi test.

* Corresponding author. Tel.: +52 222 2663100; fax: +52 222 2472940.
E-mail address: fermin@inaoep.mx (F.S. Granados-Agustín).

0030-4026/$ – see front matter © 2013 Elsevier GmbH. All rights reserved.
http://dx.doi.org/10.1016/j.ijleo.2013.07.056

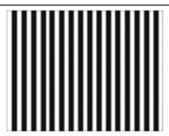
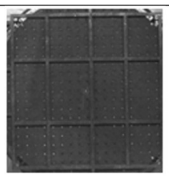
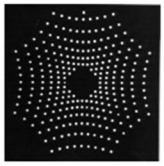
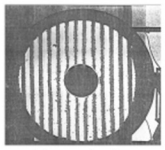
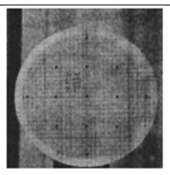
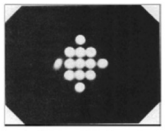
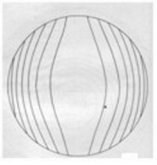
	Filter			Observed Pattern	
Type		*Size Position*	*Type*	*Tested Surface*	*Size Position*
Ronchi Ruling	 Figure 2a.	Small c.c.	Ronchigram	 Parabolic Figure 2b.	Big c.s.
Hartmann Screen	 Figure 2c.	Big c.s.	Hartmanngram	 Hyperbolic Figure 2d.	Small c.c.
Null Ronchi Grating	 Figure 2e.	Small c.c.	Null Ronchigram	 Hyperbolic Figure 2f.	Big c.s.
Null Hartmann Screen	 Figure 2g.	Big c.s.	Null Hartmanngram	 Parabolic Figure 2h.	Small c.c
Big Hartmann-Ronchi Screen	 Figure 2i.	Big c.s.	Hartmanngram	 Parabolic Figure 2j.	Small c.c.
Big Null Hartmann-Ronchi Screen	 Figure 2k.	Big c.s.	Null Hartmanngram	 Parabolic Figure 2l.	Small c.c.

Fig. 2. For the Hartmann and Ronchi tests; this figure contains two main columns called filter and observed pattern with surface tested. On each side of the columns there are written on the left hand side the filter used and the observed pattern; and on the right hand side the corresponding sizes and positions. For photographs g and h see Refs. [1] and [8].

ways, either in its theoretical and experimental concepts. In the work by Cordero et al. [9] both testing methods were studied considering the similarity between them. In another paper, by the same authors, Cordero et al. [10], a common mathematical analysis for both kinds of tests was developed, considering mainly ray tracing technique.

In Fig. 1a and b the common schemes for these Ronchi and Hartmann tests are shown. From the comparison and analysis of both tests the next common aspects were derived: (a) they measure the transverse aberration, that are used to obtain the wave front, *W*, of the optical surface or system under test, (b) normally white or other kind of light sources can be used, (c) a screen or filters are used, this means the Ronchi ruling or the Hartmann screen.

The main aim of this paper is to present the Table of Fig. 2, where some aspects of both tests are related: (i) the normal procedures of the tests, and the so called null methods; (ii) the size and position of