Application note:

SHSInspect RL module – Test of binocular telescopes

1 Introduction

This application note describes the testing of sport optics with Optocraft's SHSInspect RL module in 2Xpass configuration. Using a simple optical set-up, we measure and compare the imaging quality and wave aberrations of two binoculars: One binocular is a low cost device, the other binocular ranges in the upper price segment.

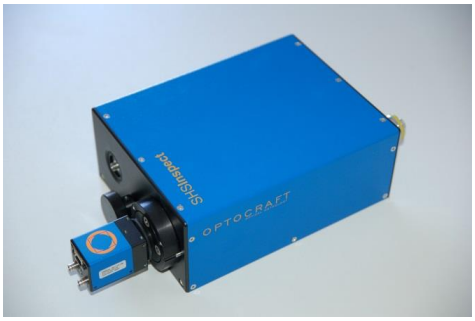

Figure 1: SHSInspect RL module with SHSCam HR

2 Experimental Setup

Figure 2 shows the setup, *figure 3* a schematic of the setup. Both binoculars are of the 8x32 class. The wave-front sensor head is of the type SHSCam HR-110 with a lateral resolution of 60 x 80 microlenses. The binocular is illuminated with the light of a LED with a wavelength of λ = 530nm and an optical power of 2mW. The beam is collimated inside the RL module, then passes the binocular twice and is detected by SHSCam. The mirror in front of the binocular has an optical quality of $\lambda/20$. The binocular is mounted on translation stages and positioned such that the Keplerian telescope inside the RL module images the binocular exit pupil plane onto SHSCam.

First, a reference measurement of the empty system is taken. Then, the binocular is inserted and positioned using the translation stages, such that the tilt of the measured wave-front is minimized. Finally, a wave-front measurement is recorded and evaluated using the software SHSWorks.

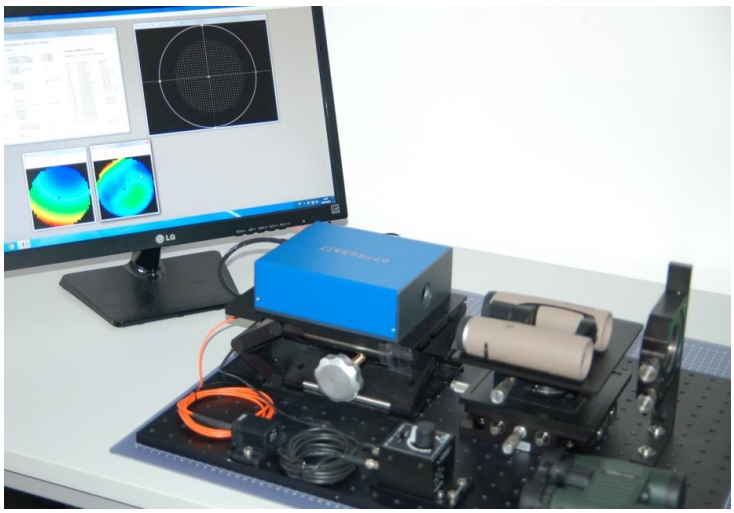

Figure 2: A photograph of the setup for binocular testing using the SHSInspect RL module

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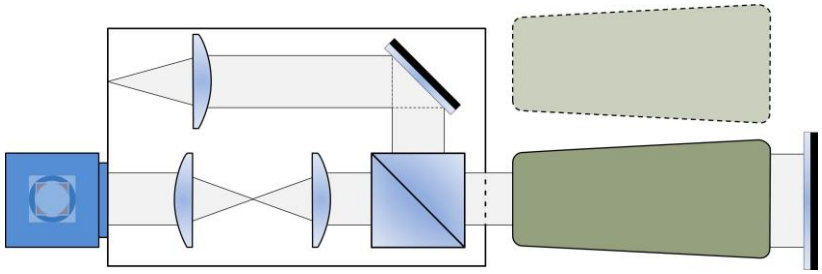

Figure 3: Schematic of the setup for binocular testing using the SHSInspect RL module

3 Results

For the binocular from the upper price segment and for the one from the low price segment, both the left and the right imaging channel were measured. To compare the single measurements, the Strehl ratio and the rms-value of the corrected wave-front (tilt and defocus removed) were calculated The measurements were evaluated on a circular mask of 3.7mm in diameter, the results are shown below in table 1. An example of the corrected wave-front and modulation transfer function are shown in figure 4.

Upper price binocular	corr. wave-front rms / λ	Strehl ratio
Left channel	0.093	0.76
Right channel	0.094	0.73
Low price binocular	corr. wave-front rms / λ	Strehl ratio
Left channel	0.251	0.20
Right channel	0.102	0.71

Table 1: Results of the wavefront measurements

For the binocular from the upper price segment, both channels have comparable imaging properties close to the diffraction limit. For the binocular from the low price segment the imaging properties of the right channel are nearly as good as in case of the high price segment binocular. The left channel, however, shows significantly worse imaging properties.

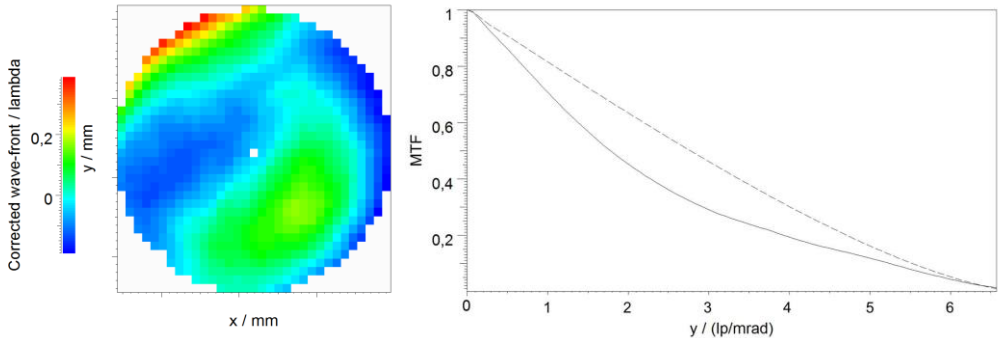

Figure 4: Measurement results for the high price segment binocular, left imaging channel. Left: corrected wave-front. Right: modulation transfer function.