Efficiency of adaptive correction application for laser beam formation in atmosphere with the use of incoherent images as reference

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Abstract—The adaptive focusing of coherent radiation beams in a turbulent atmosphere is considered theoretically. The averaged intensity distribution of the laser beam field is calculated for an adaptive focusing system in a turbulent medium, using an incoherent source image as a reference source. Phase measurements in such a scheme can be carried out with a correlation Hartmann wavefront sensor.

Keywords - correction, reference source, image, phase, coherence

We suggest a new operational scheme for an adaptive optical system which does not require a reference source to be specially created or formed. The problem of focusing coherent laser radiation through the atmosphere appears in some applications; turbulence of the atmosphere is a serious obstacle which limits the maximum achievable parameters and capabilities of optoelectronic systems [1–3]. Adaptive optics allows a significant relaxation of these limitations. However, adaptive phase correction systems require the use of an additional source to provide measurements of phase distortion in the radiation propagation channel. This source is called the reference and can be formed in different ways. Indeed, a number of research articles [4–7] exist on the use of laser guide stars for image correction as applied to problems of astronomy and atmospheric vision systems. The problem of focusing coherent laser radiation through the atmosphere arises when laser radiation transfers energy to a distant object [8–11]. The radiation reflected from the object on which the coherent laser radiation should be focused can act as a reference source in this case. An image of the object illuminated by either the Sun or radiation from an additional source can also be used as a reference source. This approach can be used in both coherent and incoherent illumination. Methods of phase detection for incoherent reference radiation are described quite thoroughly in the literature [9, 12]. The efficiency of the above adaptive correction scheme has not previously been estimated.

The goal of this work is to estimate the efficiency of such adaptive focusing of coherent laser radiation. We consider the problem of coherent laser radiation focusing in a turbulent atmosphere under adaptive phase correction [2, 6, 8, 13] using an image of the object to which the laser radiation is being sent. The intensity distribution of the generated radiation is calculated [14] on the basis of the Huygens–Fresnel principle.

References