# Reliability of the calculation results in the optical-electronic holographic computing systems

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## ABSTRACT

The problems of investigation and calculations results reliability (CRR) evaluation in holographic computing systems are considered. The analysis of the existing approaches to estimation of CRR has been overtaken. A new method of CRR is proposed. The evaluation of CRR in the systems with single and coded correlation responses regarding processing of the images and the images Fourier spectrum has been performed. The simulation results are submitted.

**Keywords:** holographic, system, calculation results reliability, image, identification.

## INTRODUCTION

One of the important problems, arising in the optical-electronic holographic computing systems (HCS) investigation is estimation of calculations results reliability, i.e. the probability of correct objects classification and determination of their coordinates.

The analysis shows, that HCS can be divided into two main classes - of invariant and normalised images processing. In the first HCS class the effect of deforming parameters on the image (rotation, change of scale and others) is reduced to equivalent shifts. To such systems belong space-dependent filtration systems [1,2] and some other [3,4]. The reference images are previously aligned, are presented in the special coordinates systems, then the identification is executed. To the second class are to be attributed optical-electronic systems[5], analogical optical processors on the basis of the special holographic filters[3] and others. The main feature of such HCS is that before the stage of the identification the images are normalised and reduced to reference on the parameters of angular orientation, scale, etc.

In this paper the problems of investigation and calculations results reliability evaluation in HCS are considered. The analysis of the existing approaches to estimation of calculations results



SPIE Vol. 3386 • 0277-786X/98/$10.00

reliability in optical-electronic holographic systems (section 1) has been overtaken. A new method of calculations results reliability in HCS (section 2) is proposed. The calculations results reliability evaluation in the systems with ordinary and coded correlation responses regarding processing of the images and the images Fourier spectrum (IFS) has been performed. The simulation results and their analysis are submitted (section 3).

The presented materials are based on the results of the theoretical and experimental researches of the images angular orientation influence on the signal and noise distribution in the correlation field of various classes systems, executed by the authors[6], as well as developed models of signal and noise in the correlation field of HCS, analytical evaluation of a signal to noise ratio taking into account the influence of the angular orientation of the reference images, as the used holographic filters[7].

## 1. THE APPROACHES TO CALCULATION RESULTS RELIABILITY EVALUATION IN THE OPTICAL-ELECTRONIC SYSTEMS

It is knows[8], that the general probability $P_c$ of the correct classification in the system is a mathematical expectation of the objects correct classification probabilities $P_i$:

$$P_c=\sum_{j=1}^{M}\alpha_i P_j=\alpha_1 P_1+\alpha_2 P_2+\ldots+\alpha_q P_q+\ldots+\alpha_M P_M \quad (1)$$

where $\alpha_i$ - is a prior probability of the i - object occurrence; M - the objects number.

Let $\alpha_i = 1/M$. Then for evaluation of classification reliability $P_c$, as follows from expression (1), it is necessary previously to define the probability $P_i$ of the objects correct classification.

There are various approaches in evaluation of probabilities $P_i$. Usually these probabilities are evaluated by the ratio of the correct solutions number to the total of investigated situations for each object. This method may be used when studying the no high quality images processing systems. But such an approach to the reliability classification evaluation in more complicated systems results in an extremely large volume of necessary investigations. For example, for evaluation of the correct classification probability using the method, based on the concept of allowable transformations of reference images, the study of the typewritten marks several tens of thousands was necessary[8].

In conformity with the other approaches[9], a prior knowledge of the noise laws distribution in the realisation of the signal and noise is necessary. However, in optical-electronic holographic computing systems the determination of these laws is a rather difficult problem in connection with the large variety of the processable images and the two-dimensional character of the signal and noise distribution.

The following approach to the probabilities $P_i$ evaluation[10] is simpler, and is based on similarity measures minimum differences calculation as which correlation coefficients are used: