Experimental estimation of the recognition reliability in the optical pattern recognition systems

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ABSTRACT

A method of the recognition reliability estimation in the optical pattern recognition systems (OPRS) is described, based on of the similarity measures differences (SMD). It was theoretically justified and experimentally confirmed a hypothesis about the distribution law of the SMD. There were calculated the reliabilities of the correct objects recognition at single and coded correlation responses in OPRS of invariant and normalized images processing.

Keywords: optical, pattern recognition, correlation, reliability, similarity measures, filter

1. INTRODUCTION

One of the important questions in optical pattern recognition represents the estimation of the objects recognition reliability.

In chapter 2 it is described a method of the recognition reliability estimation in the optical pattern recognition systems (OPRS). This method is based on minimal differences of the similarity measures, as which are used a maximum on the correlation field area value of an additive mix of the signal and noise and maximum of the light flow power, containing noise. The hypothesis about the normal distribution law of the similarity measures differences is theoretically justified.

In chapter 3 it was checked the hypothesis about the law of similarity measures differences distribution according to two criteria: on the base of experimental data it was built a normal theoretical curve, which then was compared with the experimental curve. For more careful checking of the hypothesis there was used the Pierson's criteria.

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In chapter 4 there are described the results of the experimental estimation of the objects recognition reliability in 2 kinds of the OPRS: of invariant and normalized images processing.

In conclusion there are formulated the recommendation regarding the possibilities of utilization of the optical correlation systems for invariant pattern recognition.

2. THE METHOD OF THE RECOGNITION RELIABILITY ESTIMATION IN OPRS

The described method of the recognition reliability estimation is based on the minimal similarity measures differences RM between images, taking into account the properties of the correlation field, analysed in the optical pattern recognition systems[1,2]:

$RM_{ij} = \min\Delta_{ij} = Q_{ii} - \max Q_{ij}$,
where Q_{ii}, Q_{ij} are the measures of image similarity at autocorrelation and cross correlation.

The probability of objects correct recognition P_i is evaluated as probability that $RM_{ij}>0$:

$P_i = P(RM_{ij} > 0) = P(\min\Delta_{ij} > 0)$.

Let P_D be the detecting threshold power of the optical correlation field scanning device. If the power of the light flow, dropping on the device photoreceiver is equal to or exceeds the P_D level, this device generates an electrical signal, which will be a feature of the object recognition. Otherwise the object will not be recognized.

Thus, the probability of correct recognition P_i of an object can be determined as probability, that the maximum power of noise $\max[P_N]$ in a correlation field will be less that the detecting threshold level P_D:

$$P_i = P(P_D > \max_{\Omega}[P_N]) = P(P_D - \max_{\Omega}[P_N]) > 0, \quad (1)$$

where Ω - the correlation field area.

Hence, in OPRS, as a measure of similarity Q_{ii}, can be accepted the parameter P_D, which is equal or proportional to a maximum on the correlation field area value of an additive mixture of the signal and noise: $\max\{P_{SN}\}$ The value $P_{SN}=I_{SN}S_{PD}$, where I_{SN} - intensity of an additive mixture of the signal and noise, S_{PD} - the area of photoreceiver. As the I_{SN} can depend[3] on angular orientation Θ_O of the input image in OPRS, it is reasonable to consider the general case, i.e. to accept as a degree Q_{ii} of similarity the minimum of P_{SN} to the parameter Θ_O:

$$Q_{ii} = \max_{\Omega}\{\min_{\Theta_o}[P_{SN}]\}$$

As a unit of similarity Q_{ij} can be accepted the maximum of the light flow power, containing the noise on the correlation field area: