Objects recognition by using identity vectors signatures

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ABSTRACT:
In this work we present a new methodology to recognize objects by using identity vectors signatures (Is) obtained for both the target and the problem image. In this application, (Is) is obtained by means of a simplification of the main features of the original image in addition of the properties of the Fourier transform. Identity vectors signatures are compared using a nonlinear correlation. This new methodology recognizes objects with a confidence level above 95.4% and it has a low computational cost.

Key words: Image recognition, nonlinear correlation, rings mask, one-dimensional signatures, Fourier transform.

REFERENCES AND LINKS

1. Introduction.
Pattern recognition is an expanding field in optical and computer research since the first appearance of the classical matched filter [1]. In recent years, different methods have been proposed for objects identification which have been used in several areas where the main objective of these methods is the correct identification regardless of the image variations may occur [2-7]. In this work we present a new method to recognize objects by using identity vectors signatures which is used to recognize radiolarians, but it can be used for the recognition of other objects.

2. Methodology.
The procedure used in this work uses the original image statistical properties as well as the Fourier transform properties and provides a significant reduction of the image information of size $m \times n$ to one-dimensional vector of $1 \times 256$ consequently with low computational cost.
Identity vectors signatures are compared using a k-law nonlinear correlation.

2.a. Identity vectors signatures.
First, the image to be recognized is denoted by \( f(x,y) \). In the step 1, a vector of 256 elements is created and denoted by \( h(m) \), which represents the values in grayscale of the image with a range of values from 0 to 255 (histogram). Thus, when the vector \( h(m) \) is created, the rotation invariance is obtained. Then, in step 2, the identity vector is calculated by

\[
  id_{vec}(m) = \frac{h(m)}{\text{pixel}_{num}} \cdot m, 
\]

where \( \text{pixel}_{num} \) is the number of pixels of the object, in this step the scale invariance is obtained. Then, the modulus of Fourier transform is calculated in order to obtain the identity vector signature which is denoted by \( I_s \) and it is obtained as (step3)

\[
  I_s(w) = |\mathcal{F}\{id_{vec}(m)\}|, 
\]

where \( \mathcal{F} \) represents the Fourier transform of the function \( id_{vec} \) and \(|*|\) represents the modulus.

2.b. Nonlinear correlation.
A nonlinear correlation between the target and the problem image is used. In general a nonlinear filter is defined by

\[
  NF = |F(u,v)|^k e^{-i\phi(u,v)}, \quad 0<k<1, 
\]

where \( |F(u,v)| \) represents the modulus value of the Fourier transform of the image, \( k \) is the nonlinear strength factor that takes values between zero and one and \( \phi(u,v) \) is the phase of the Fourier transform. We can manipulate the discriminate capacities of the nonlinear processor changing the \( k \) values in this interval and therefore determine the best \( k \) of the nonlinear filter. In this system \( k=0.3 \) was used.

3. Results.
To evaluate the performance of this digital system, 20 test images of different species of radiolarians were used. The results in all the cases presented a confidence level of at least 95.4% . In terms of computational cost, this new methodology takes about 0.02 s per image.

4. Conclusion.
The results show that identity vectors and their respective signatures are an efficiently methodology to identify objects and provide the necessary information to identify the object despite the significant reduction of information. This methodology has a confidence level of at least 95.4% and it has a low computational cost.

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