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TRACE TRANSFORM OF SPATIAL IMAGES[1]

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The method considered in the article is a follow-up of the 2D Trace-transform method introduced and developed by N.G. Fedotov. A 3D Trace-transform both possesses the advantages of the 2D Trace-transform and uses the current practical experience in grappling with problems related to the invariance to a group of motion when analyzing and recognizing images.

Introduction

Research in pattern recognition has been carried out since the middle of the past century. Quite a number of various algorithms have been developed by now to solve pattern recognition tasks.

Technological developments of the late 20th century enhanced significantly the application of computer vision techniques and helped create 3D models of objects to solve a great variety of applied problems. The one of a predefined database automatic search for 3D models proves particularly topical.

Various techniques of spatial image analysis are generally highly tailored to analyze and recognize a specified type of objects. Moreover, there are very few techniques totally invariant to a group of motions of 3D objects, which would allow to obtain features more resistant to coordinate noise.

The present paper considers a mathematical model of applying Trace-transform to spatial images recognition, as well as the invariance of the features obtained to a group of motions.

Mathematical model of a Trace-transform

Suppose F is an original 3D model. Let us define a plane as tangent to the reference unit sphere with the center in the origin, passing through a base point x and at a distance r from the origin with the predetermined angles ω and φ, where $\eta = [\cos\varphi \sin\omega, \sin\varphi \sin\omega, \cos\omega]$ – is a unit vector in R^3, ω – angle between planes $\Pi(\eta, r)$ and OXY, φ – angle between planes $\Pi(\eta, r)$ and OXZ.

Let us scan the model with a grid of parallel planes with distance Δh between the planes at angles ω and φ. The relative position of 3D object F and each scanning plane Ï $(\eta(\omega,\varphi),r)$ are characterized by the number G, computed according to a certain rule *HyperT*: G=HyperT($F \cap \Pi(\eta(\omega,\varphi),r)$). The characteristics indicated could be provided by a sectional area, character of the neighborhood of such an area, *etc*. Then, scanning should be performed for the new value of angle ω, which has got the discrete increment $\Delta\omega$, with a lattice of planes with the same distance Δh between the scanning planes. Again, we apply the same selected *HyperT* rule to the meet of the new plane $\Pi(\eta(\omega+\Delta\omega,\varphi),r)$ with the 3D object F, and go on like that until we make a halfway equal to π radian.

Scanning is going on for the new value of angle φ, with the discrete increment $\Delta\varphi$. In a like manner, we "go round the object" from $\Pi(\eta(\omega,\varphi),r)$ to $\Pi(\eta(\omega,\varphi+\pi-\Delta\varphi),r)$ for each angle $\varphi+\Delta\varphi$.

For the density of planes to stay uniform, it is significant that angles are not to be changed arbitrarily, but according to a support grid to be considered in the *Features invariant to rotation* Section of the article.

The result of computing *HyperT*-functional depends upon three parameters (r,ω,φ) of the

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