ISDL REPORT

FOUNDATIONS OF PARAMETRIC TRANSFORMATIONS

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ABSTRACT

The classic problem of recognition of an image invariant to its rotation, translation and scale is considered. There are many approaches to solving this problem. Most make use of a *template transform* on the image to a space that is invariant to these operations. These include synthetic discriminant mappings, the methods of circular harmonics, image moments and the use of Fourier & Mellin transform magnitudes. In the absence of noise, most of these template transforms perform with 100% detection probability. Their false alarm probability, however, invariably increases in comparison to optimal detection algorithms which have been dismissed on practical grounds due to required computational intensity. The reason for the reduction in performance is simply that image information has been destroyed in the template transform. A template transform that is in some sense invertible would not display such information loss. The *parametric transform* in certain cases has this desirable property.

We illustrate parametric transformation with an example. An image, $g(x,y)$, is passed through two filters with frequency responses $H_X(u,v)$ and $H_Y(u,v)$. The corresponding outputs are $X(x,y)$ and $Y(x,y)$. We form a two dimensional template for the function $g(x,y)$ by parametrically plotting these two functions on the (X,Y) plane. Note that any shifted version of $g(x,y)$ will have the same transform. If the filters are both circularly symmetric, the parametric transform will also be rotationally invariant. If both filters are only a function of the angular frequency variable (*e.g.* fan filters), the transform will be scale invariant. Note that the number of filters and therefore the dimension of the parametric transform can be increased. Significantly, some parametric transforms can be inverted to one of the members of its invariance class. In such cases, the parametric transform contains all of the information of the original image. By applying appropriate detection algorithms, we would therefore expect to maintain a lower false alarm probability than in cases where information is lost.

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