Study on wavelet modified MACH and EMACH filter for pattern recognition

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In this paper, we study the influence of wavelet transform on maximum average correlation height (MACH) filter and extended MACH (EMACH) filter for distortion-invariant pattern recognition. Use of wavelet transform enhances the performance of both MACH and EMACH filters which ultimately minimizes the required number of filters to identify a target rotated at any angle from 0 to 360° in-plane rotations. It improves the autocorrelation peak intensity. MACH filter has shown excellent performance on automatic target recognition. This correlation filter is designed based on soft constraints. The MACH filter relaxes the correlation peak constraints and maximizes the peak intensity of the average training image. The filter is designed by a method of minimizing the average similarity measure (ASM). This minimization leads to a compact set of correlation planes that resemble each other and exhibit the least possible variations. The mathematical equation of the MACH filter is expressed as,

$$h = (I + S_x)^{-1} m \tag{1}$$

where I is an identity matrix, m is the Fourier transformed average training images, and S_x is a matrix expressed as

$$S_x = \frac{1}{N}\sum_{i=1}^{N}(X_i - M)^{+}(X_i - M) \tag{2}$$

EMACH filter is a modified version of the earlier one with improved clutter rejection and background noise cancellation ability. The filter is designed in the same way as MACH filter with an additional parameter β, whose value varies from 0 to 1. It provides sharper correlation. Mathematically, it is expressed as,

$$h = \left(I + S_x^{\beta}\right)^{-1} C_x^{\beta} \tag{3}$$

where $C_x^{\beta} = \frac{1}{N}\sum_{i=1}^{N}(X_i - \beta m)(X_i - \beta m)^{+}$ & $S_x^{\beta} = \frac{1}{N}\sum_{i=1}^{N}(X_i - (1-\beta)M)^{+}(X_I - (1-\beta)M)$

In this study, we have used a two-dimensional Mexican hat wavelet, which is the second derivative of the Gaussian function and is represented as,

$$h(x,y) = \left[1 - \left(x^2 + y^2\right)\exp\left(-\frac{x^2 + y^2}{2}\right)\right] \tag{4}$$

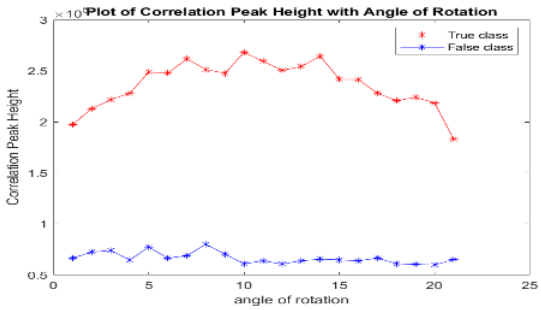

Figure 1 Correlation peak height with wavelet modified MACH filter

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