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Editorial

Statistical Modeling for Image Fusion

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DESCRIPTION

The purpose of image fusion is to mix information from multiple images of an equivalent scene into one image that ideally contains all the important features from each of the original images. The resulting fused image are going to be thus more suitable for human and machine perception or for further image processing tasks. Many image fusion schemes are developed within the past. In general, these schemes are often roughly classified into pixel-based and region-based methods. It has been shown that comparable results are often achieved using both sorts of methods with added advantages for the region based approaches, mostly in terms of the likelihood of implementing more intelligent fusion rules. On the opposite hand, pixel based algorithms are simpler and thus easier to implement.

The majority of pixel based image fusion approaches, although effective, haven't been developed supported strict mathematical foundations. Only in recent years more rigorous approaches are proposed, including those supported estimation theory. A Bayesian fusion method has been proposed, allowing to adaptively estimating the relationships between the multiple image sensors so as to get one enhanced display. The multi resolution image representation was assumed to follow a normal distribution. This limiting assumption was relaxed, where a generalisation has been presented, allowing modelling both Gaussian and non-Gaussian distortions to the input images. An Expectation Maximisation algorithm was wont to estimate model parameters and therefore the fused image. This approach was further refined by using hidden Markov models in order to describe the correlations between the wavelet coefficients across decomposition scales. A combined Wavelet and Cosine Packets image fusion algorithm was presented. Counts of input image coefficients contributing to the fused image were modelled by a log-linear distribution. The final fused image was constructed supported the arrogance intervals for the possibilities of a fused pixel coming from a nth input image being selected within a packet from multiple hypotheses testing.

Recent work on non-Gaussian modelling for image fusion has been proposed. Specifically, an image fusion prototype method, originally proposed, has been modified to account for non-Gaussianity of the image distributions. Since there exist strong evidence that wavelet coefficient of images are very well modeled by Symmetric Alpha-Stable (SαS) distributions, second-order statistics used, have been replaced by Fractional Lower-Order Moments (FLOMs) of SαS distributions. This novel approach to image fusion resulted in improved performance compared to earlier pixel level fusion techniques.

As is that the case with many of the recently proposed techniques, our developments are made using the wavelet transform, which constitutes a strong framework for implementing image fusion algorithms. Specifically, methods based on multi scale decompositions consist of three main steps: first, the set of images to be fused is analysed by means of the wavelet transform, then the resulting wavelet coefficients are fused through an appropriately designed rule, and eventually, the fused image is synthesised from the processed wavelet coefficients through the inverse wavelet transform. In implementing the algorithms described during this chapter we make use of the Dual-Tree Complex Wavelet Transform (DT-CWT) that has been shown to supply near shift invariance and improved directional selectivity compared to the standard wavelet transform. Due to these properties, image fusion methods implemented within the complex wavelet domain are shown to outperform those implemented using the discrete wavelet transform.

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