**Recovering biological fluids signature from near-infrared hyperspectral images**

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A newly developed methodology [M. Ahmad et al 2020] based on wavelet transform, grey-level co-occurrence matrices and principal component analysis (PCA) is described for the analysis of near-infrared hyperspectral images (NIR HSI) of semen droplets on various fabrics [C. S. Silva et al 2017]. Biological fluids, such as semen, are systems that have complex compositions which are not always retrieved or detectable. In different forensic scenarios, the biological fluids can be found on a variety of surfaces, considerably increasing the effort necessary to detect and analyze them in a nondestructive manner. NIR imaging provides a solution. However, as fabrics have quite rough surfaces, the semen spectral signature is hampered by strong light scattering and high absorbance of thick and colored fabrics. An additional issue is the lack of spatial selectivity, i.e., there is no region where only semen is present. This is also the case for the spectral mode, meaning that the spectral signature of semen overlaps with that of fabric. To cope with these issues, the presented methodology applies wavelet transform to analyze the different spatial frequency contributions present in the images, in this way different spatial features can be enhanced and captured. Descriptors derived by co-occurrence matrices are then used to summarize these local spatial features per spectral wavelength. Afterwards PCA is utilized to highlight the main sources of spatial variability across the spectral dimension. The methodology allows for the isolation of some of the spatially and spectrally distinct components in the hyperspectral image, highlighting their mutual link.

**Keywords:** near-infrared hyperspectral images; spatial features; wavelet transform; grey-level co-occurrence matrix; multivariate image analysis

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