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Infrared and Visible Image Fusion Using the Top Hat Transform

Yan Claude Bajac Figueredo[1] Juan Pablo Bazan[2]
Universidad Comunero, Paraguay
Julio César Mello-Román[3] José Luis Vázquez Noguera[4] Horacio Legal-Ayala[5]
Facultad Politécnica, Universidad Nacional de Asunción, Paraguay

Infrared (IR) images help us detect hidden targets in the environment based on the radiation they emit. They work well in daytime, nighttime conditions or in weather environments such as rain or fog. However, visible images (VIS) provide us with textural details of scenes that are better appreciated by the human eye. Therefore, extracting useful image features and preserving details effectively is a crucial part of image fusion. Mathematical morphology is composed of techniques used in image processing and analysis. The Top Hat transform and its variants is a widely used mathematical morphology operation for extracting bright and dark features from images [3]. It has also been used for Visible-NIR image fusion [1]. This work presents a visual and numerical analysis of performing visible and infrared image fusion using the Top Hat transform. In general, the fusion algorithm using Top Hat is competitive, because it provides better results in contrast, brightness and texture than other algorithms with which the comparison was performed.

Verification of the performance of the fusion algorithm using Top Hat was performed using a public database of visible and infrared images for testing. The proposed method was compared with: Average Fusion (AF), Laplacian Pyramid (LP), Ratio of low-pass Pyramid (RP), CurVelet Transform (CVT) and Gradient Transfer Fusion (GTF) [2]. The performance of the methods was assessed with the metrics: Entropy (E), Standard Deviation (SD), Spatial Frequency (SF), Average Gradient (AG), Mutual Information (MI). The higher the value of the metrics, the better the fused images will be. Table 1 shows that as the size of the structuring element increases the Top Hat based fusion algorithm performs better on the SD, E and SF metrics. In Figure 1, we can visualize an example of "T3" images. The original images are Fig. 3(a) and Fig. 3(b) [4]. Proposed, they preserve mostly the infrared zone of the person and the texture of the jungle.

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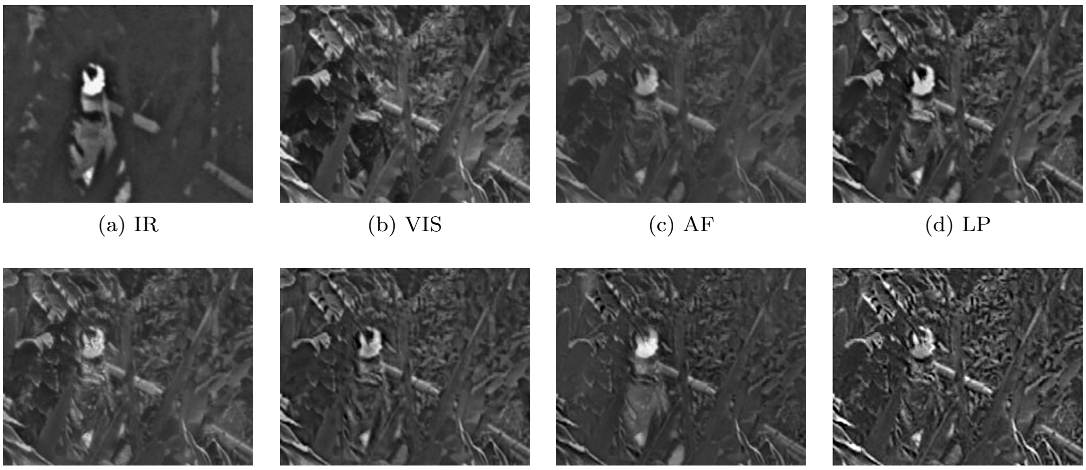
[1] yanbajac@gmail.com
[2] jpb_py@hotmail.com
[3] juliomello@pol.una.py
[4] jlvazquez@pol.una.py
[5] hlegal@pol.una.py

Table 1: Numerical results obtained by the Algorithms.

Image	Algorithms	SE	SD	E	AG	SF	MI
Camp	AF	-	22.651	6.238	0.028	6.447	0.035
	LP	-	29.129	6.655	0.059	11.434	0.033
	RP	-	27.730	6.551	0.061	13.032	0.031
	CVT	-	26.939	6.531	0.120	10.924	0.031
	GTF	-	26.862	6.678	0.127	8.493	0.045
	FTHC	3	24.566	6.420	0.035	13.535	0.030
		5	27.038	6.572	0.039	16.060	0.029
		7	29.935	6.699	0.050	17.714	0.028
		9	32.201	6.784	0.055	18.715	0.028
T3	AF	-	18.006	5.936	0.051	5.310	0.050
	LP	-	29.788	6.669	0.070	10.131	0.046
	RP	-	25.138	6.414	0.049	8.632	0.045
	CVT	-	24.977	6.440	0.069	9.623	0.034
	GTF	-	23.059	6.091	0.028	8.331	0.025
	FTHC	3	19.627	6.080	0.090	8.340	0.042
		5	24.445	6.381	0.114	12.099	0.034
		7	29.649	6.655	0.111	14.629	0.031
		9	34.167	6.854	0.108	16.287	0.030



(a) IR (b) VIS (c) AF (d) LP

(e) RP (f) CVT (g) GTF (h) FTHC

Figure 1: Imágenes fusionadas de “T3".

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