Evaluation of Color STIPs for Human Action Recognition

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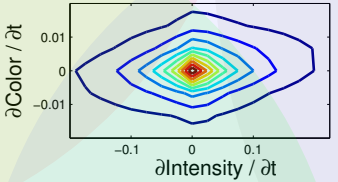
1. Why Color for Action Recognition?

Because:

Motion is the dominant cue in action recogition

Color gives:

-**More** Motion observations
-**Better** Motion estimation

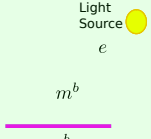


2. Reflection Model and Color Space

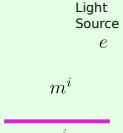
Shafer85

Di-chromatic Model, $\mathbf{f} = e(m^b\mathbf{c}^b + m^i\mathbf{c}^i)$

Diffuse Reflection



Specular (interface) Reflection



e:Energy
c^i:Body Color
c^b:Interface Color
m^i:Scalar
m^b:Scalar

Opponent color space

$$\begin{pmatrix} O_1 \\ O_2 \\ O_3 \end{pmatrix} = \begin{pmatrix} R-G \\ R+G-2B \\ R+G+B \end{pmatrix}$$

	Intensity	Chromatic	Norm.-Chromatic	Hue
Representation	O_3	$[O_1, O_2]$	$\left[\frac{O_1}{O_3}, \frac{O_2}{O_3}\right]$	$\frac{O_2}{O_1}$
Invariant to	-	Highlights	Shadows	Hl. & Sh.
Reference	I	C	N	H

3. Multi-channel STIP Detectors

Laptev-IJCV05
Dollar-ICCVw05

Multi-channel Harris STIPs

$g(\cdot;\cdot,\cdot)$:3D Gauss f^j:image channel j n_c :nr channels

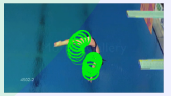
$$V = (V^1, V^2, ..., V^{n_c})^T \quad V^j = g(\cdot;\sigma_o,\tau_o) * f^j(\cdot)$$

$$V_d = (V_d^1, V_d^2, ..., V_d^{n_c})^T, d \in \{x, y, t\}$$

$$S = g(\cdot;\sigma_i,\tau_i) * \begin{pmatrix} V_x \cdot V_x & V_x \cdot V_y & V_x \cdot V_t \\ V_y \cdot V_x & V_y \cdot V_y & V_y \cdot V_t \\ V_t \cdot V_x & V_t \cdot V_y & V_t \cdot V_t \end{pmatrix}$$

Multi-channel Gabor STIPs

$$R = \sum_{j=1}^{nc} (g(\cdot;\sigma_o) * h_{ev}(\cdot;\tau_o) * V^j)^2 + (g(\cdot;\sigma_o) * h_{od}(\cdot;\tau_o) * V^j)^2$$



4. Multi-channel STIP Descriptors

KlaserBMVC08

g:3D Gradient, P: nx3 matrix of polyhedron face centers

HOG3D $\boldsymbol{q} = (q_1, ..., q_n)^T = \frac{P \cdot \boldsymbol{g}}{||\boldsymbol{g}||_2}$

Channel Integration: $\boldsymbol{g''} = \sum_{j=1}^{nc} \boldsymbol{g}^j \cdot \boldsymbol{g}^j$

Channel Concatenation: $\boldsymbol{g'} = \{\boldsymbol{g}^j\}, j = 1, ..., n_c$

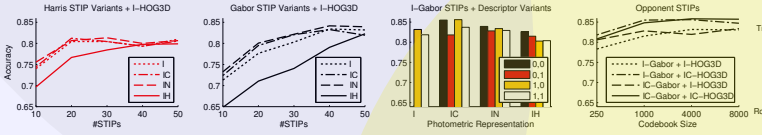
	Gradient Orientation	Gradient Direction
Channel Integration	$\mathfrak{C}_{1,1} : D/2$	$\mathfrak{C}_{1,0} : 1D$
Channel Concatenation	$\mathfrak{C}_{0,1} : n_c D/2$	$\mathfrak{C}_{0,0} : n_c D$

5. Results, UCF-Sports, UCF-11, UCF-50

Detector settings, Gabor: $\sigma_o = 2 \quad \tau_o = \sqrt{8}$ Harris: $\sigma_o = \sqrt{2}i, i \in \{2,3,4\} \quad \tau_o = \sqrt{2}j, j \in \{1,2\}$

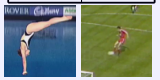
Cuboid settings, $\Delta_x = \Delta_y = 18\sigma_o, \Delta_t = 8\tau_o$ Spatio-temporal pooling: 3x3x2

Bag of features, with SVM, χ^2kernel, voc-size: 4000. Each experiment repeated 3x, typical stddev: 0.2 - 1%



		$I_{,0}$	$IC_{1,0}$	$IC_{0,0}$	$IN_{1,0}$	$IN_{0,0}$	$I_{,1}$	$IC_{1,1}$	$IC_{0,1}$	$IN_{1,1}$	$IN_{0,1}$
UCF11	$I-Gabor$	73.8%	77.5%	78.2%	76.0%	76.4%	71.6%	75.8%	74.2%	73.8%	74.6%
	$IC-Gabor$	73.8%	78.4%	78.1%	76.6%	76.3%	71.5%	75.4%	73.7%	73.9%	74.3%
	$IN-Gabor$	74.5%	77.5%	**78.6%**	76.7%	76.4%	72.4%	76.0%	74.6%	74.2%	74.0%
UCF50	$I-Gabor$	68.3%	71.7%	70.9%	71.2%	72.1%	68.8%	72.6%	69.7%	71.8%	72.0%
	$IC-Gabor$	68.5%	71.8%	70.8%	71.2%	71.9%	68.8%	72.4%	69.8%	71.5%	72.4%
	$IN-Gabor$	68.4%	71.8%	71.1%	71.0%	71.8%	68.5%	**72.9%**	69.9%	71.6%	72.5%

UCF Sports	
Intensity	Color
83%	86%



UCF 11	
Intensity	Color
74%	79%

UCF 50	
Intensity	Color
69%	73%

Ref.	Description	%
Reddy	Scene context + STIP(MBH)	76.9%
	Scene Context	47.6%
	STIP(MBH)	71.9%
Solmaz	Gist3D + STIP(HOG/HOF)	73.7%
	Gist3D	65.3%
	STIP(HOG/HOF)	54.3%
Sadanand	Action Bank	57.9%
	STIP(HOG/HOF)	47.9%
Here	Color STIP(HOG3D)	72.9%