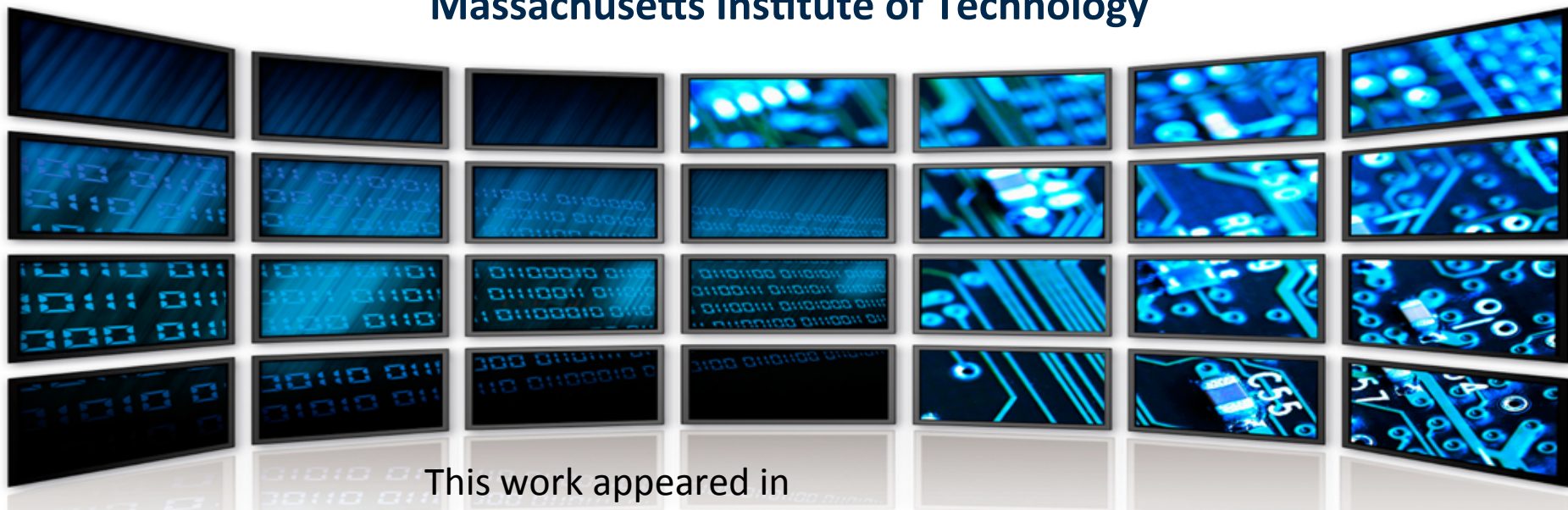


# Rotate Intra Block Copy

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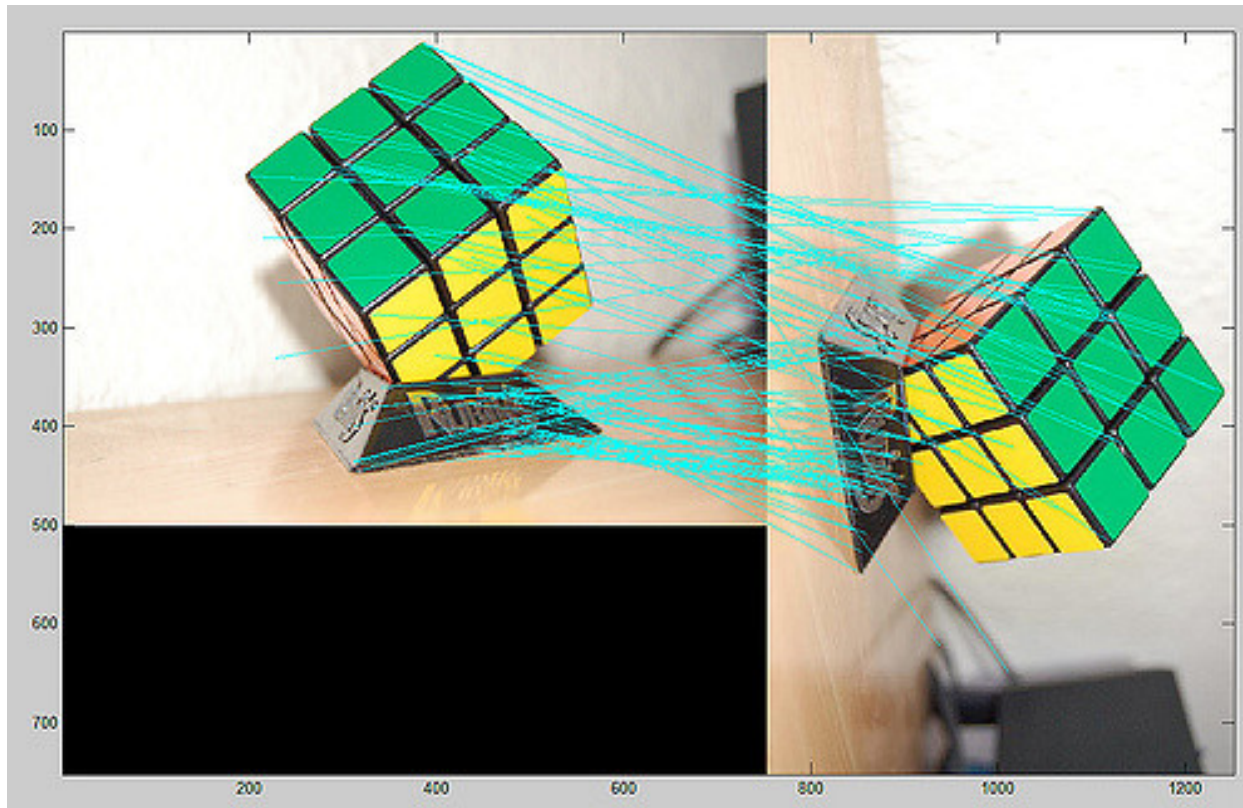
This work appeared in  
Z. Zhang, V. Sze, "Rotate Intra Block Copy for Still Image Coding,"  
*IEEE International Conference on Image Processing (ICIP)*, 2015.

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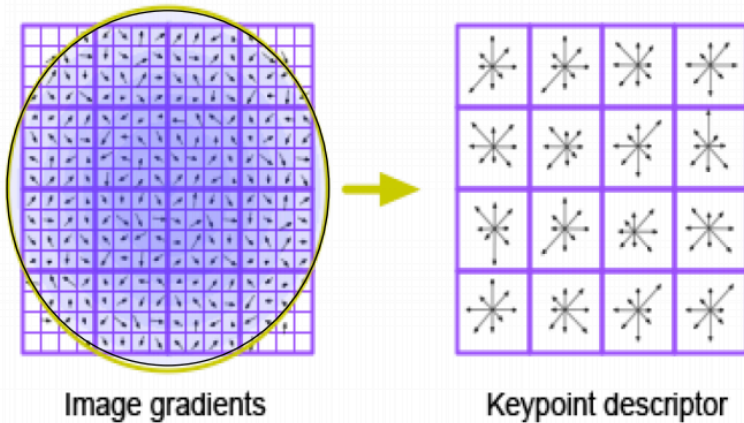
# SIFT feature matching



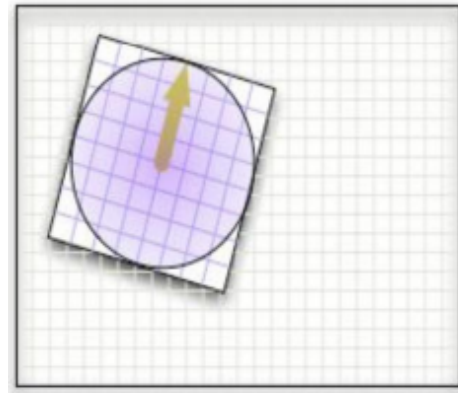
[DG Lowe,  
IJCV 2004]

SIFT features are widely used to establish correspondence between two similar images

# SIFT is Rotate Invariant



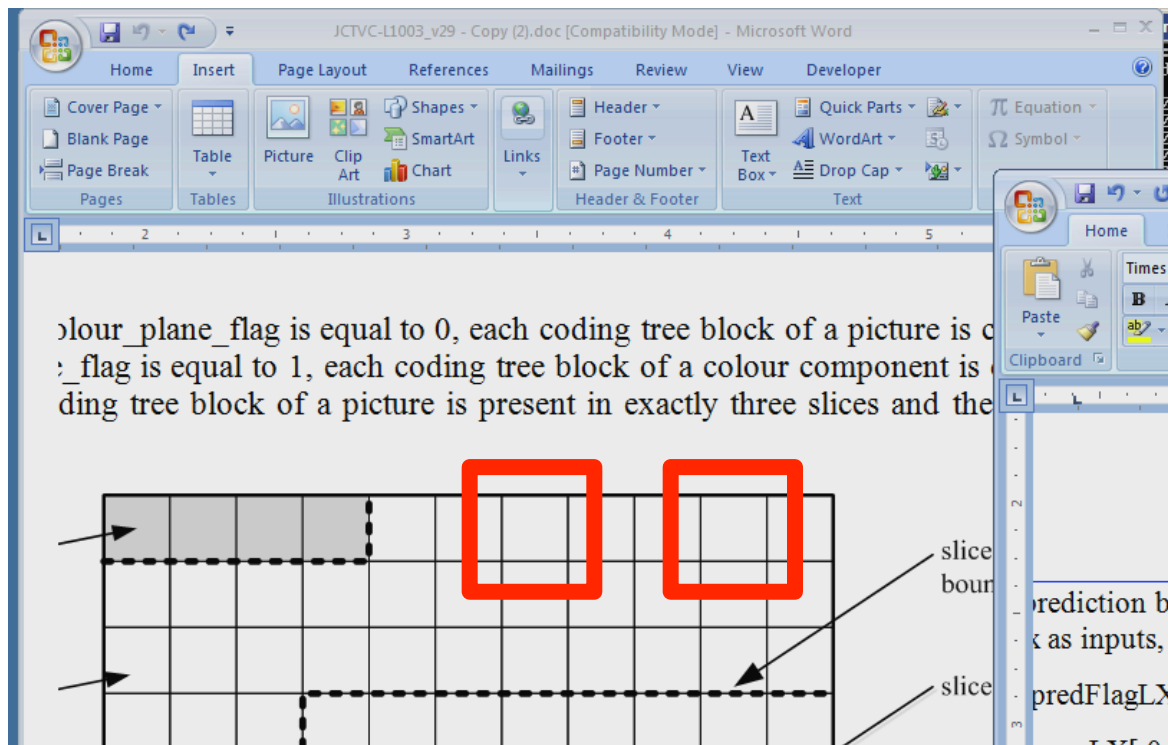
SIFT descriptor



Canonizing the rotation

Before the matching, SIFT descriptors are normalized to the canonical pose (dominant gradient) so that patches of different orientation can be matched.

# Intra Block Copy for Still Image Coding

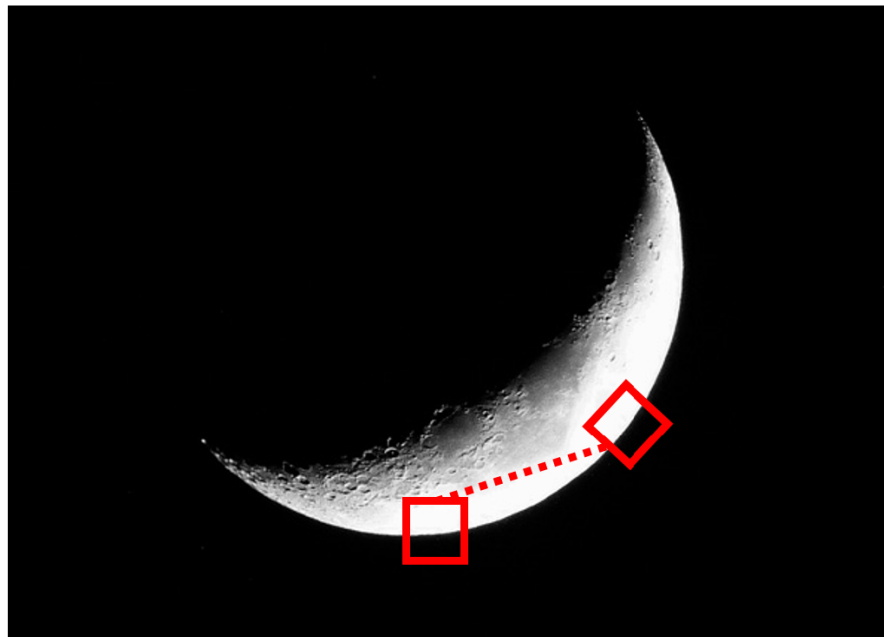
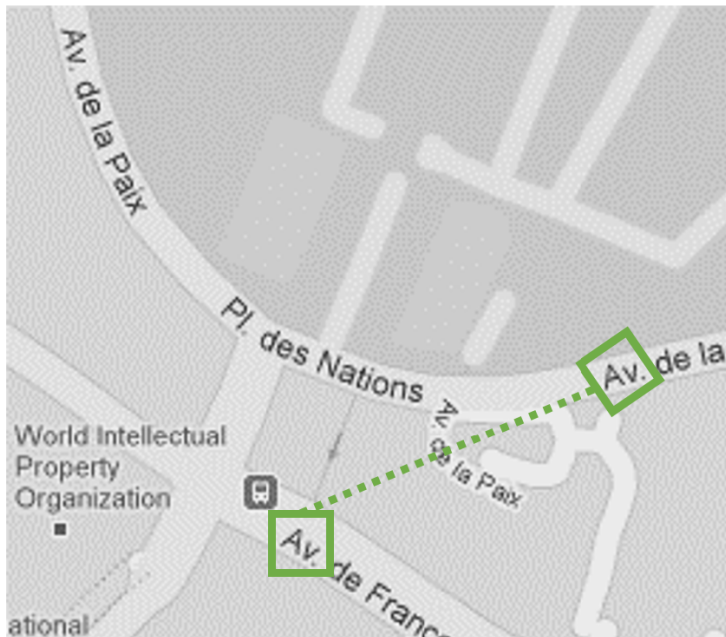


[Yu et al., JVT-C151],  
 [Budagavi et al., JCTVC-M0350],  
 [Peng et al, JCTVC-N0256]

Use one block to **predict** repetitive blocks. Only encode the **difference (residual)**.

NOT rotate invariant. Limited to screen content.

# Rotate Intra Block Copy



**Repetitive** structures with **rotation**

In both **screen content** and **camera captured images**



# Reduction of Residual Energy



HEVC



HEVC + Block Copy



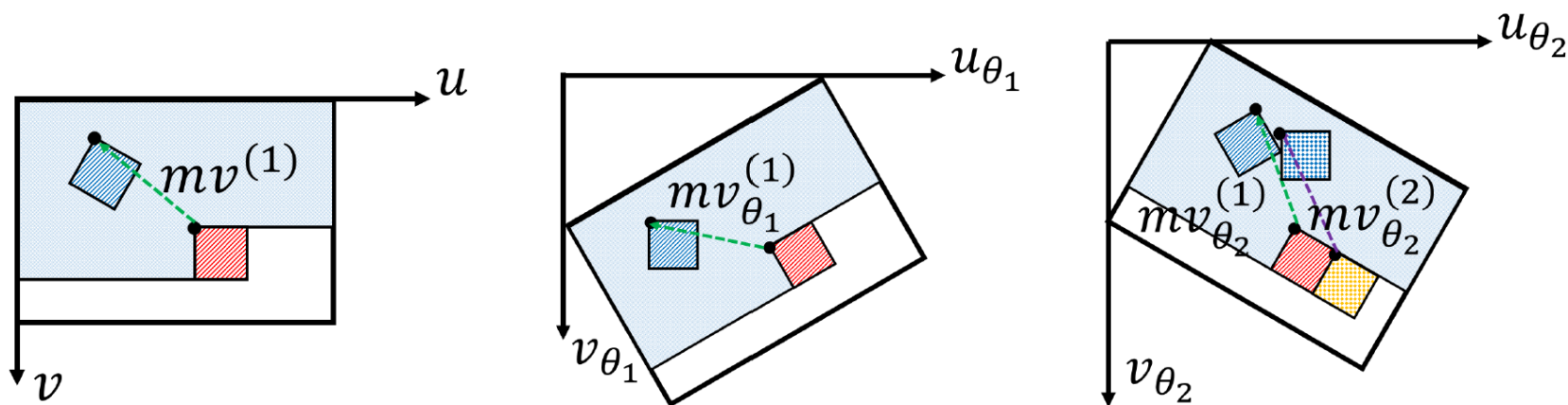
HEVC + Rotate  
Block Copy

40% reduction of residual energy over HEVC  
27% reduction of residual energy over HEVC + Block Copy

However, there is overhead in signaling the rotate angle and motion vector

First frame of *ParkScene* Sequence

# Motion Vector Prediction



Motion vectors need to be on the same rotated coordinate system

$mv_{\theta_2}^{(2)}$  is encoded as  $mv_{\theta_2}^{(2)} - \text{round}\left(R_{\theta_2-\theta_1} mv_{\theta_1}^{(1)}\right)$

Where  $R_{\theta_2-\theta_1} = \begin{bmatrix} \cos(\theta_2 - \theta_1) & -\sin(\theta_2 - \theta_1) \\ \sin(\theta_2 - \theta_1) & \cos(\theta_2 - \theta_1) \end{bmatrix}$

Reduce average bit rate of motion vector difference by 25%

# HEVC + Intra Block Copy vs. HEVC + Rotate Intra Block Copy

	Sequence	Residual reduction	BD-rate
<b>Class C</b>	RaceHorse	23.66%	-4.54
	PartyScene	27.64%	-4.45
	BQMall	17.92%	-2.63
	BasketballDrill	22.12%	-3.40
<b>Class D</b>	BQSquare	30.82%	-4.99
	BasketballPass	15.44%	-1.84
	BlowingBubbles	7.59%	-2.81
	RaceHorse	28.97%	-4.42
<b>Class E</b>	FourPeople	18.09%	-2.54
	Johnny	12.79%	-2.35
	KristenAndSara	15.67%	-2.43
<b>Class F</b> <i>screen content</i>	BasketballDrillText	21.15%	-3.64
	SlideShow	29.01%	-7.43
	SlideEditing	19.12%	-0.74
<b>Class C Average</b>		22.83%	-3.76
<b>Class D Average</b>		20.70%	-3.52
<b>Class E Average</b>		15.52%	-2.44
<b>Class F Average</b>		23.09%	-3.94
<b>Overall Average</b>		20.71%	-3.44

*Evaluate on First Frame of JCT-VC test sequences*

- Residual Energy reduction of 20.7%
- BD-rate change -3.4%

*Z. Zhang, V. Sze, "Rotate Intra Block Copy for Still Image Coding," IEEE International Conference on Image Processing (ICIP), 2015.*