Robust Tracking in Low Light and Sudden Illumination changes

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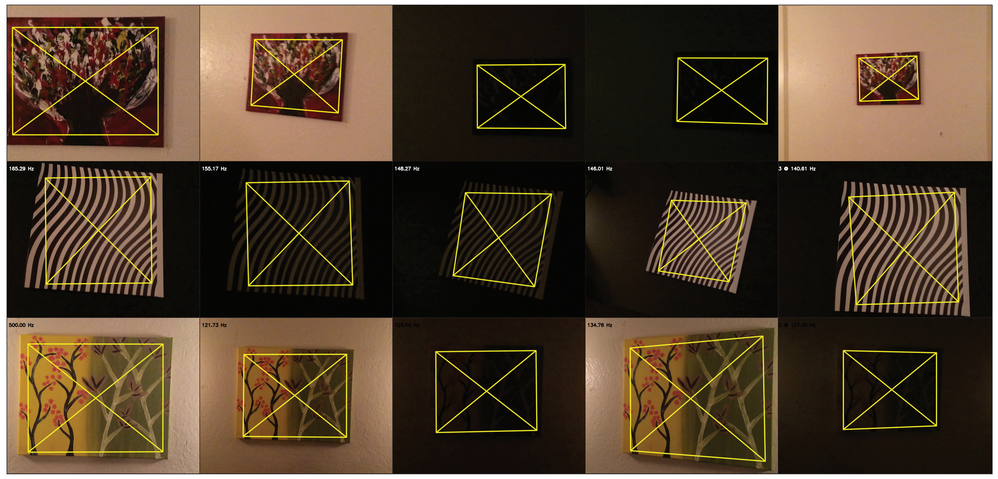
Goal: Robust, precise and efficient tracking under challenging illumination conditions



Approach: Illumination invariant tracking using binary descriptors

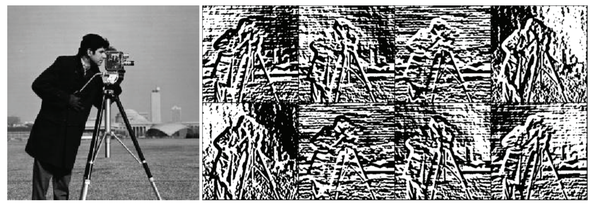
8	12	200	8<42	12<42	200<42	1	1	0
56	42	55	56<42		55<42	0		0
128	16	11	128<42	16<42	11<42	0	1	1

Census Transform/LBP is invariant to monotonic changes

Efficient to compute

Must be matched under a binary norm (e.g. Hamming) to preserve invariance.

But, binary norms are non-differentiable



Bit-Planes

Bit-Planes: Multi-channel binary descriptor image

Preserves the Hamming distance under least-squares

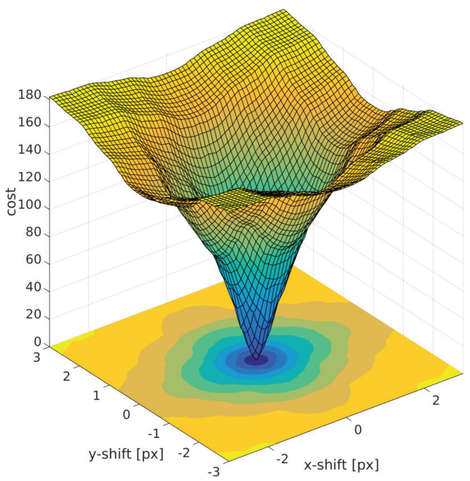
```
a = 1 0 1 1 0 0 1 0
b = 0 0 1 1 1 0 1 0
    1 0 0 0 1 0 0 0
```

hamming(a,b) = SSD(a,b)

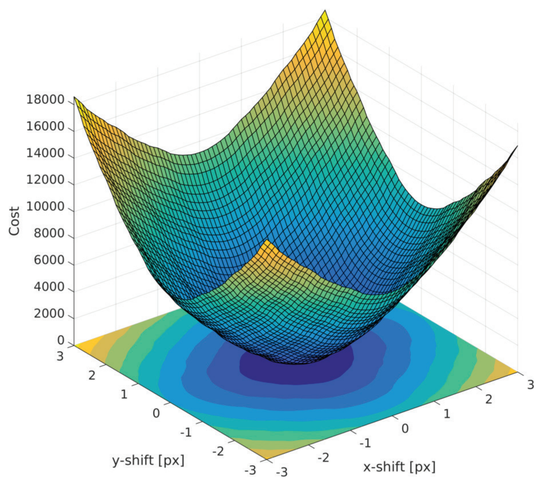
Linearization: Lucas-Kanade with Bit-Planes

descriptor channels (8 for Bit-Planes)

$$\sum_{\mathbf{x}\in\Omega_0}\sum_{j=1}^{d}\|\phi_0^j(\mathbf{x})-\phi_1^j(\mathbf{x}'(\boldsymbol{\theta}))\|^2$$

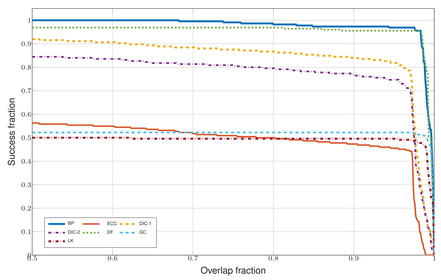


Bit-Planes



Raw intensity

Performance: Robust, accurate and real-time



data courtesy of Gauglitz et al.

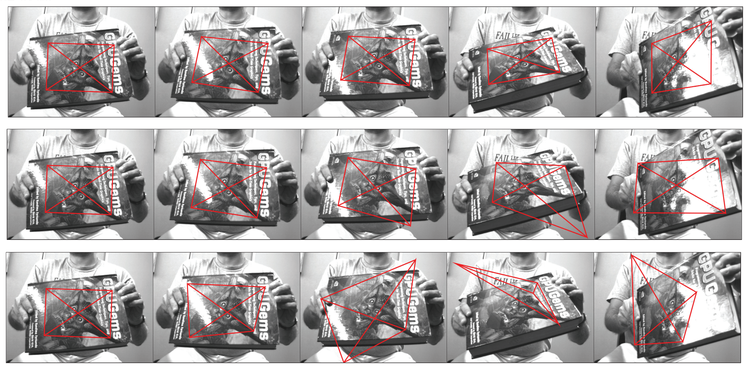
Run time (fps) on mobile devices

	iPad Air 2			iPhone 5s		
template size	BP	ORB	BRISK	BP	ORB	BRISK
70×55	**123**	N/A	N/A	**50**	N/A	N/A
150×115	**48**	15	15	**22**	13	13
311×230	**17**	12	14	**10**	8	11

Bit-Planes

Descriptor Fields

Gradient Constraint



data courtesy of Silveira et al.

Future work

Improving basin of convergence (e.g. by incorporating intensity information)

Application to other domains (e.g. Direct Visual Odometry)