

# Focus is All You Need: Loss Functions for Event-based Vision



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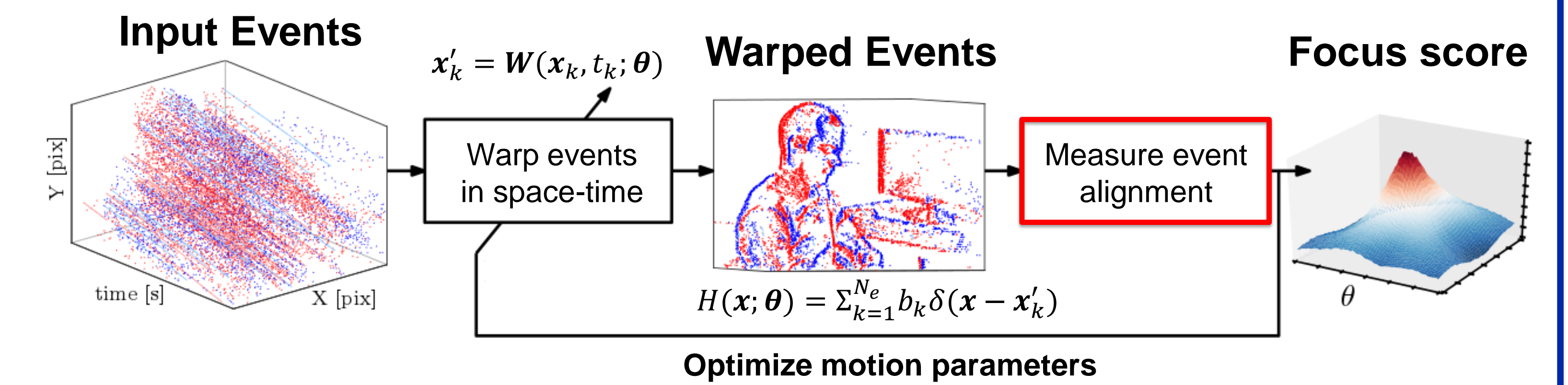
**Motivation:** Event cameras promise to revolutionize computer vision by unlocking challenging scenarios: **HDR, high speed, low latency.**

**Goal:** Develop and compare **loss functions** for **event-based optimization problems** (3D reconstruction, motion estimation, etc.) that can be used in **unsupervised learning**

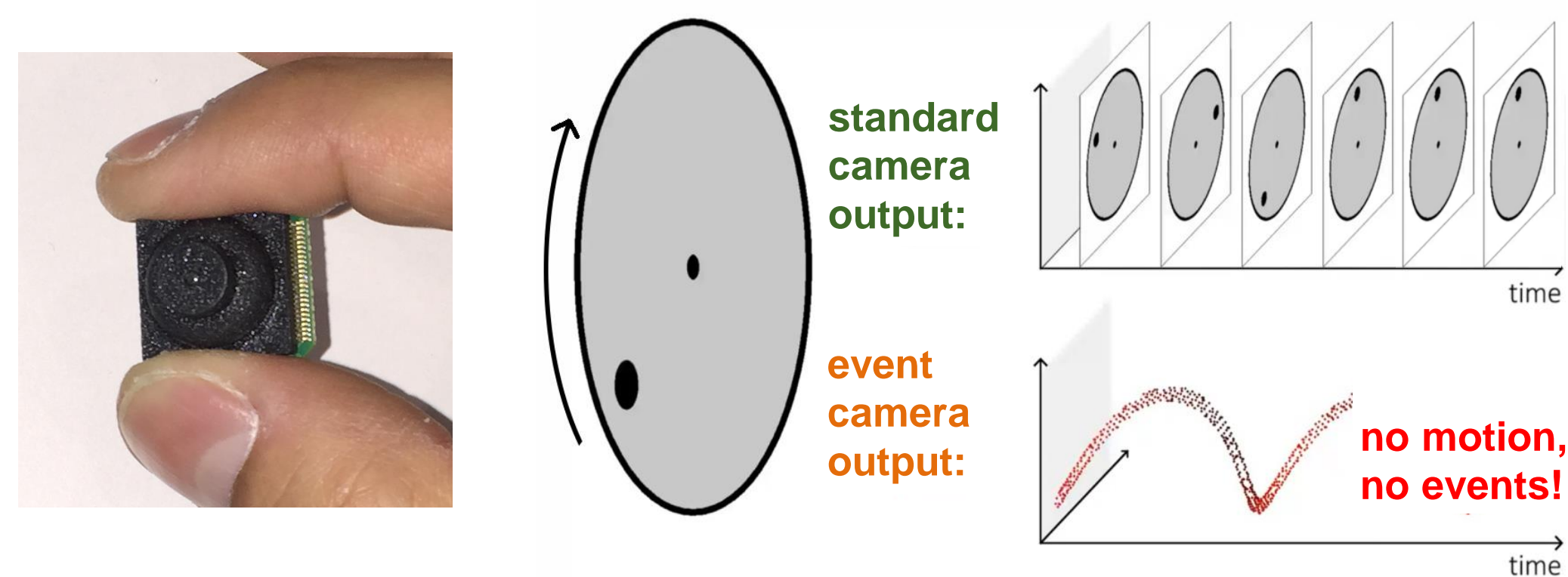
## Key Ideas:

- **Motion estimation by Focus Maximization.**
- **Connect event-based vision and shape-from-focus.**
- **Compare multiple (>20) objective functions.**
- **What functions are the best? Practical conclusions.**
- **Applications:** depth and motion estimation, segmentation.

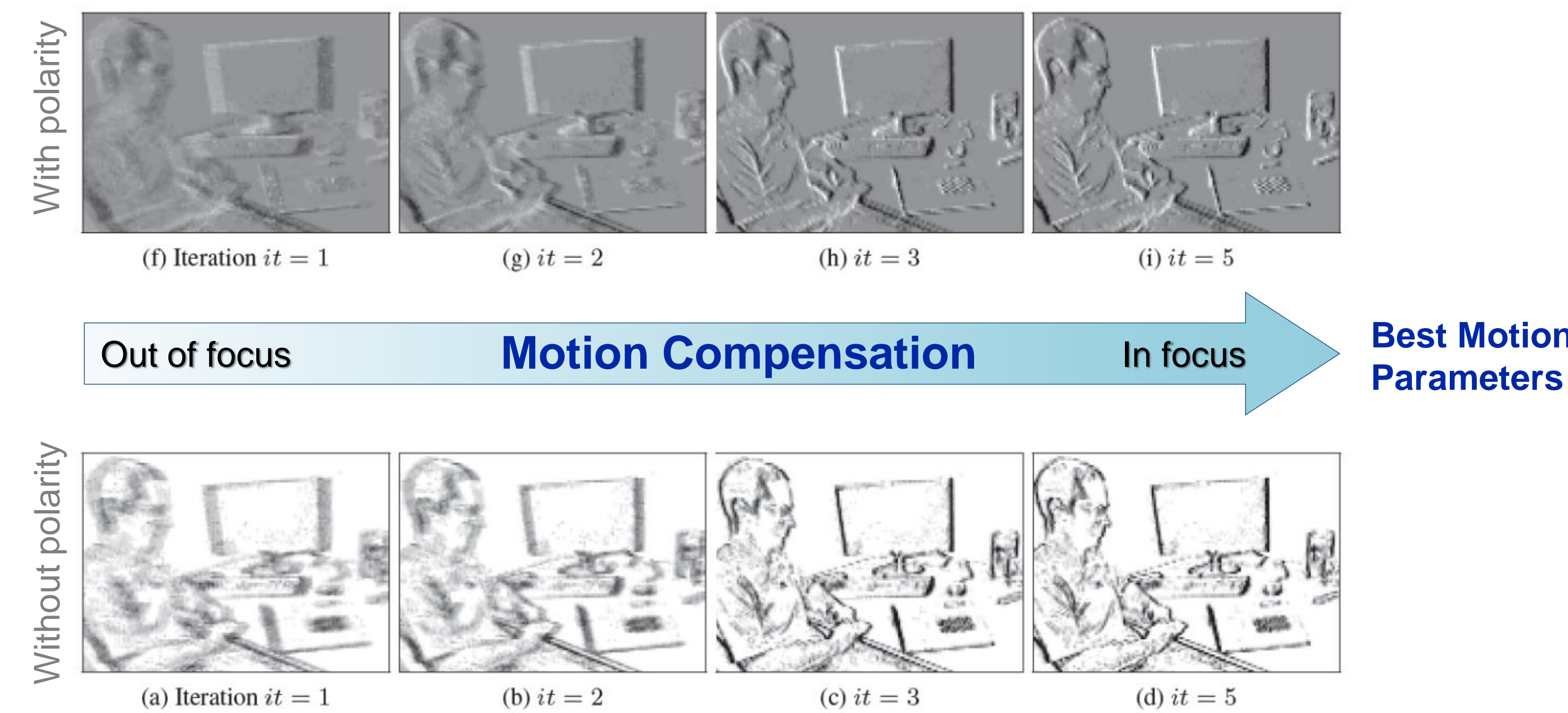
## Motion Compensation Framework



## What is an Event Camera?



- Only transmits **brightness changes**.
- Output is a stream of **asynchronous events**.
- **Advantages:** low latency, no motion blur, HDR.



## Focus Loss Functions

Dispersion

Sharpness

Combined

Focus Loss Function	Type	Spatial?	RMS w/o	RMS w/	Time [ $\mu$ s]
Variance	Statistical	No	18.52	18.94	16.90
Mean Square	Statistical	No	19.93	19.02	25.11
Mean Absolute Deviation	Statistical	No	19.46	19.58	78.11
Mean Absolute Value	Statistical	No	-	19.77	23.89
Entropy	Statistical	No	28.50	26.54	271.85
Image Area	Statistical	No	25.85	18.85	1098.64
Image Range	Statistical	No	28.66	28.72	263.11
Local Variance	Statistical	Yes	18.21	18.40	78.48
Local Mean Square	Statistical	Yes	24.81	19.86	137.20
Local Mean Absolute Dev.	Statistical	Yes	21.37	18.74	177.15
Local Mean Absolute Val	Statistical	Yes	-	24.10	243.58
Moran's Index	Statistical	Yes	24.28	23.43	116.39
Geary's Contiguity Ratio	Statistical	Yes	23.87	19.50	181.73
Gradient Magnitude	Derivative	Yes	17.83	18.10	128.46
Laplacian Magnitude	Derivative	Yes	18.32	17.58	293.80
Hessian Magnitude	Derivative	Yes	18.41	17.93	569.55
Difference of Gaussians (DoG)	Derivative	Yes	20.85	19.25	189.90
Laplacian of Gaussians (LoG)	Derivative	Yes	20.36	17.77	127.65
Variance of Laplacian	Stat. & Deriv.	Yes	18.26	18.01	327.60
Variance of Gradient	Stat. & Deriv.	Yes	18.69	19.08	872.03
Variance of Squared Grad.	Stat. & Deriv.	Yes	18.72	18.95	653.62
Variance of Mean Timestamp	Statistical	No	82.89	-	24.43

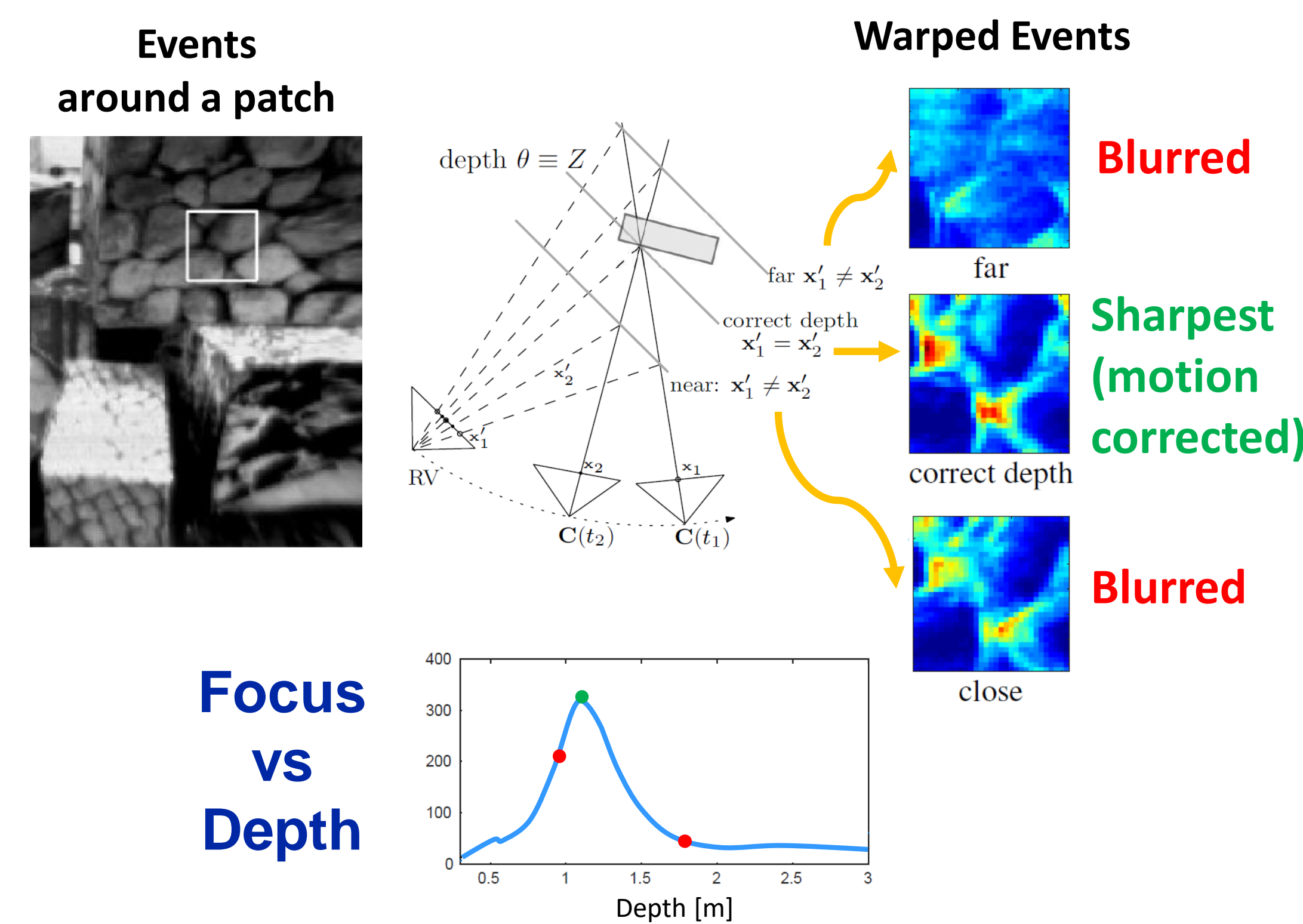
## Videos, survey paper and resources!



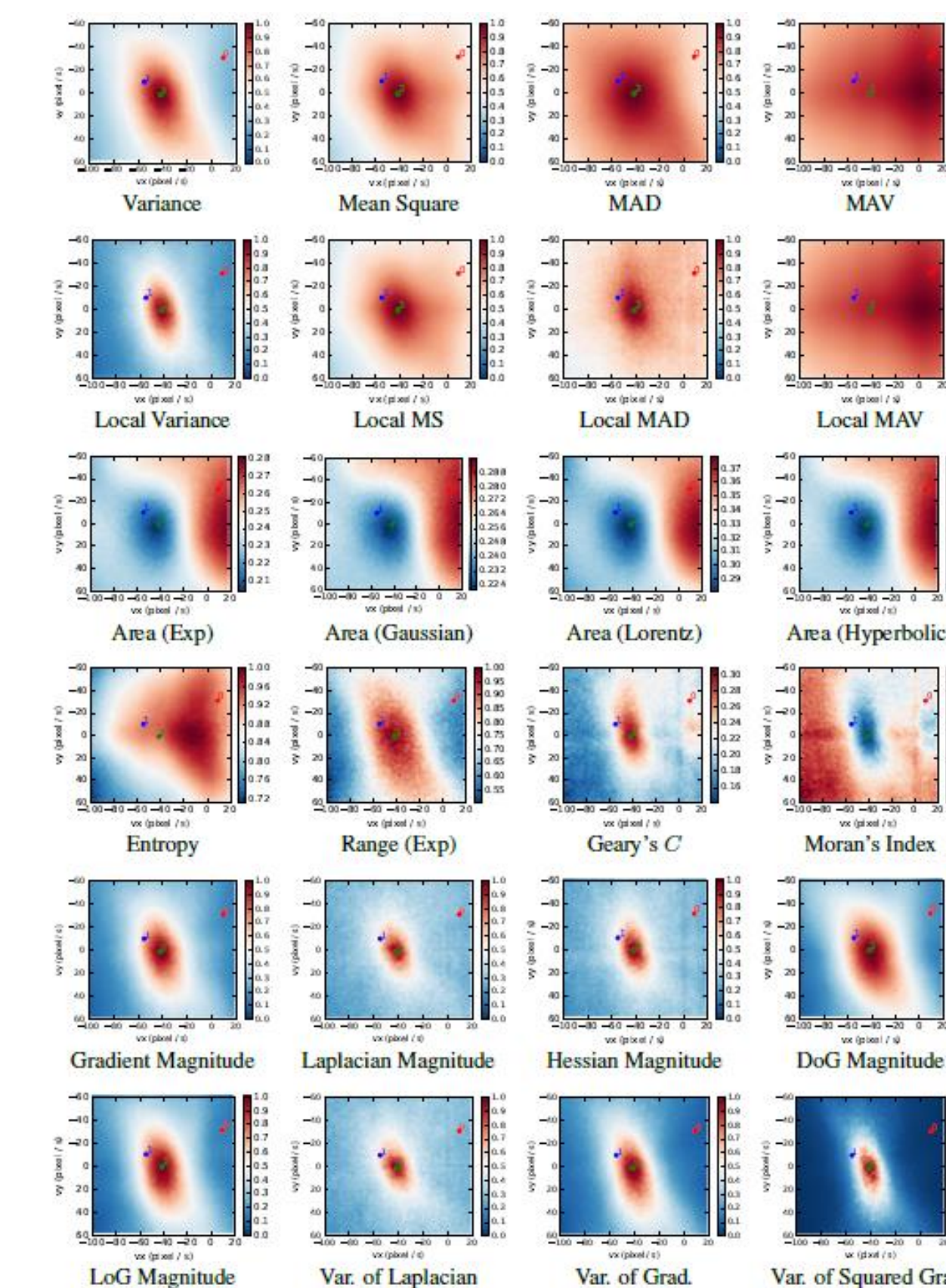
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## Connection with Shape-from-Focus

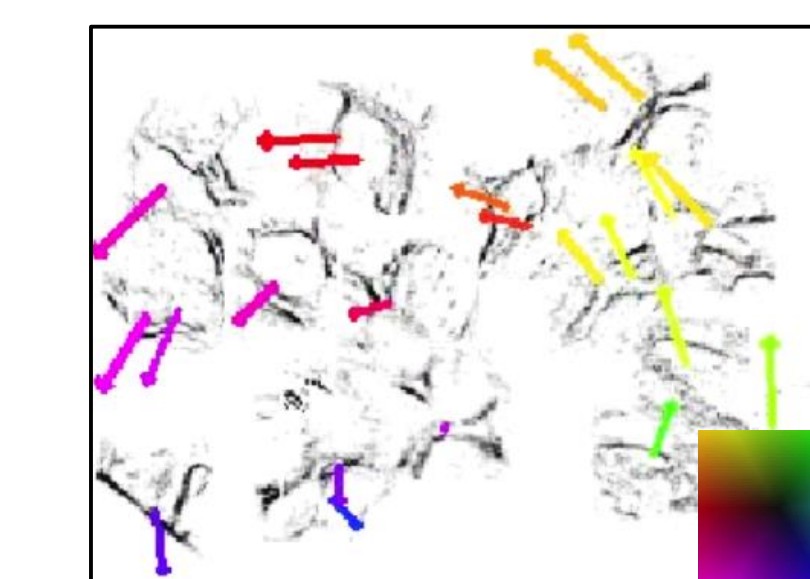


## Focus Scores



## Applications

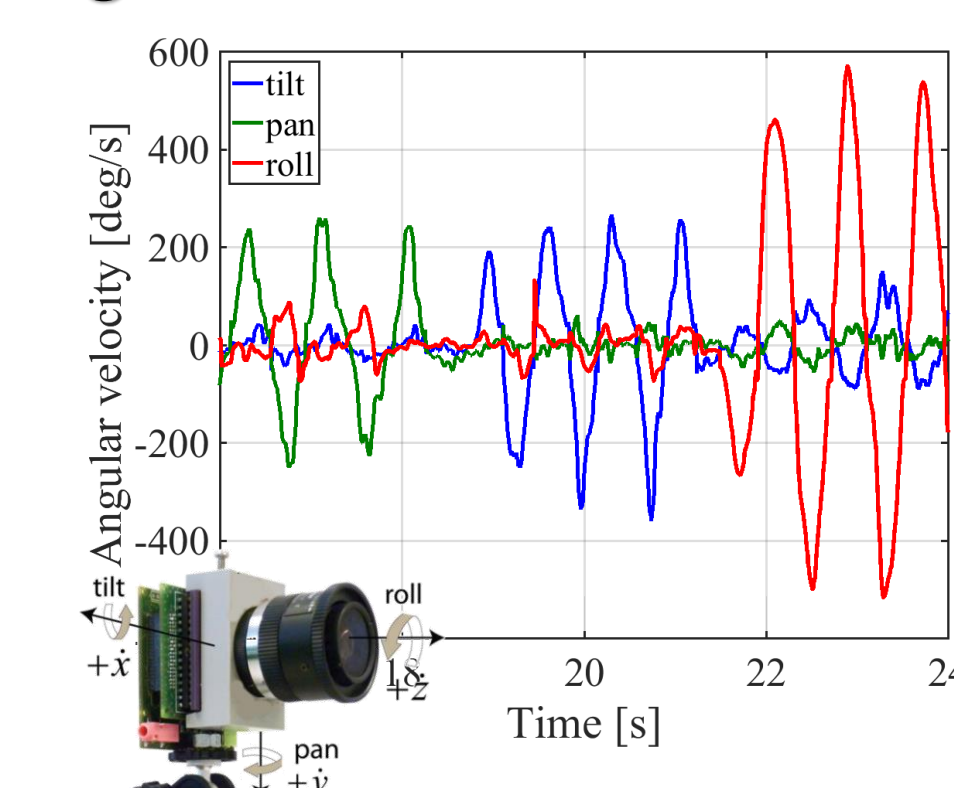
Optical Flow



3D reconstruction



Ego-motion Estimation



Segmentation

