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Video Acceleration Magnification

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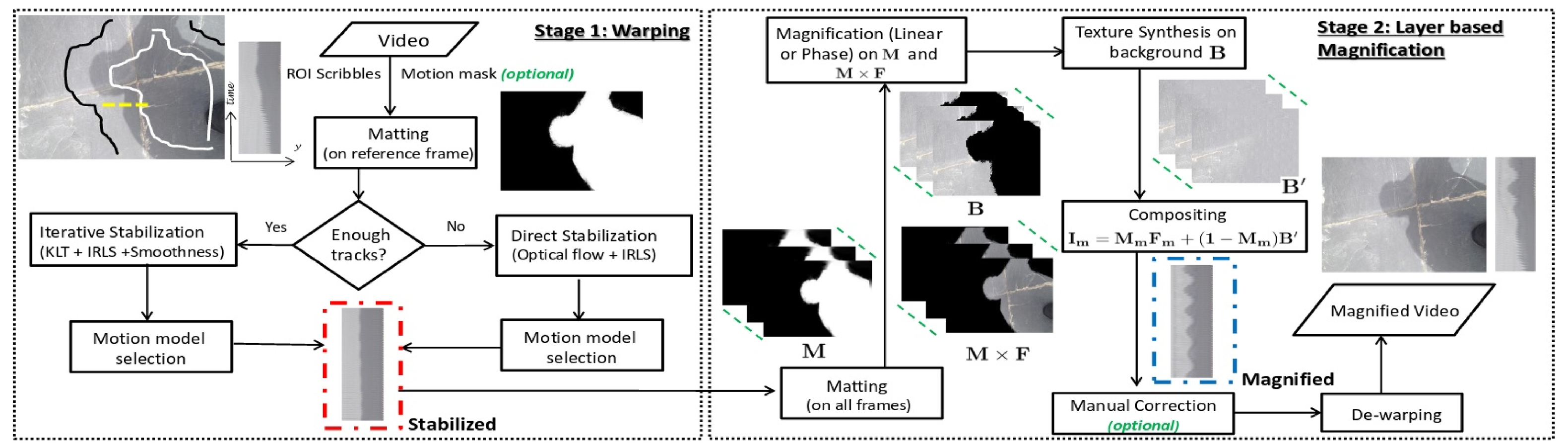
(1) Motivation:

- Magnify small motion in the presence of large motion.
- Applications: Predictive maintenance, Medical, Sports.

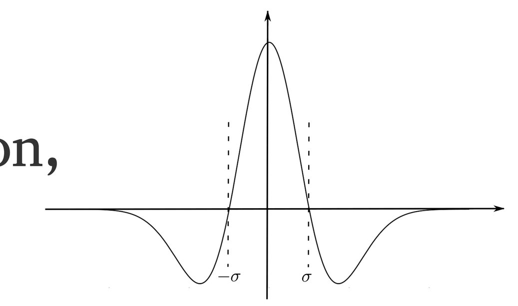
(2) Related Work:

- Current techniques:
  - either assume no large motion is present [2,3],
  - or rely on user-annotations to identify the small motion to be magnified [1] (DVMAG):



(3) Temporal Acceleration Filtering:

- Magnify small motion and ignore large motion, using the Laplacian filter:



- For signal I(x,t), the Taylor expansion [3] of its magnification is:

$$\hat{I}(x,t) \approx f(x) + (1+\beta)\delta(t)\frac{\partial f(x)}{\partial x} + (1+\beta)^2\delta^2(t)\frac{1}{2}\frac{\partial^2 f(x)}{\partial^2 x}. \quad (1)$$

- The non-linear part, acceleration, is:

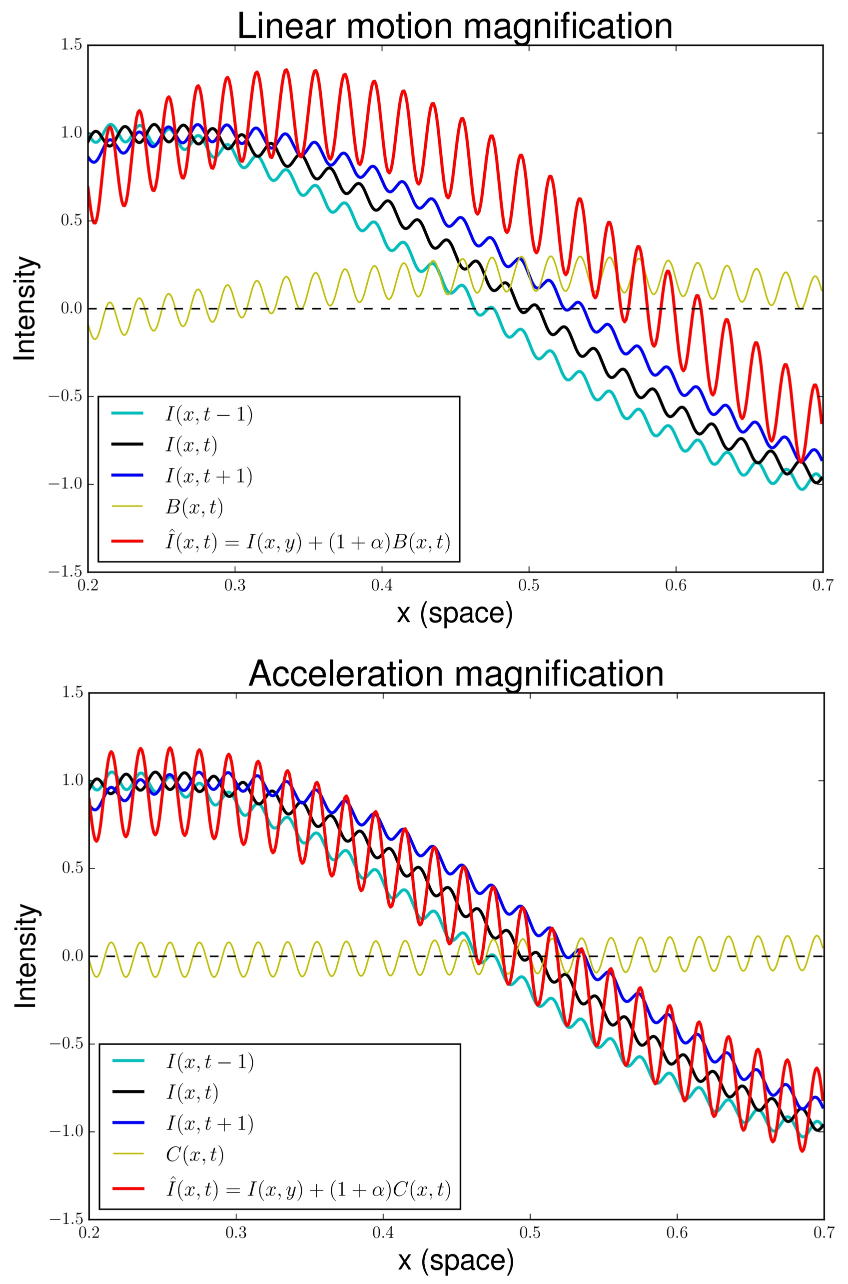
$$\hat{I}(x,t) - \hat{I}_{\text{linear}}(x,t) \approx (1+\beta)^2\delta^2(x)\frac{1}{2}\frac{\partial^2 f(x)}{\partial^2 x}, \quad (2)$$

where we note $(1+\beta)^2 = \alpha$, with $\alpha > 0$.

- The result of applying a temporal acceleration (Laplacian) filter, captures the second-order offset.

$$C(x,t) = \delta^2(x)\frac{1}{2}\frac{\partial^2 f(x)}{\partial^2 x} \overset{\text{def}}{=} I(x,t) \otimes \frac{\partial^2 G_\sigma(t)}{\partial^2 t}, \quad (3)$$

where $\frac{\partial^2 G_\sigma(t)}{\partial^2 t}$ is a temporal Laplacian filter.



$$\hat{I}(x,t) = I(x,t) + \alpha C(x,t).$$

(4) Conclusions:

- We magnify deviations from linear motion: acceleration, based on second-order Gaussian derivative.
- Tested on both intensity changes, as well as motion changes, encoded as phase in the Fourier domain.
- Our real-world videos show potential in the domain of mechanical quality control (Cat-toy, Drone), medical domain (Parkinson-I and Parkinson-II), in sports (Gun).

(5) References and Project Webpage:

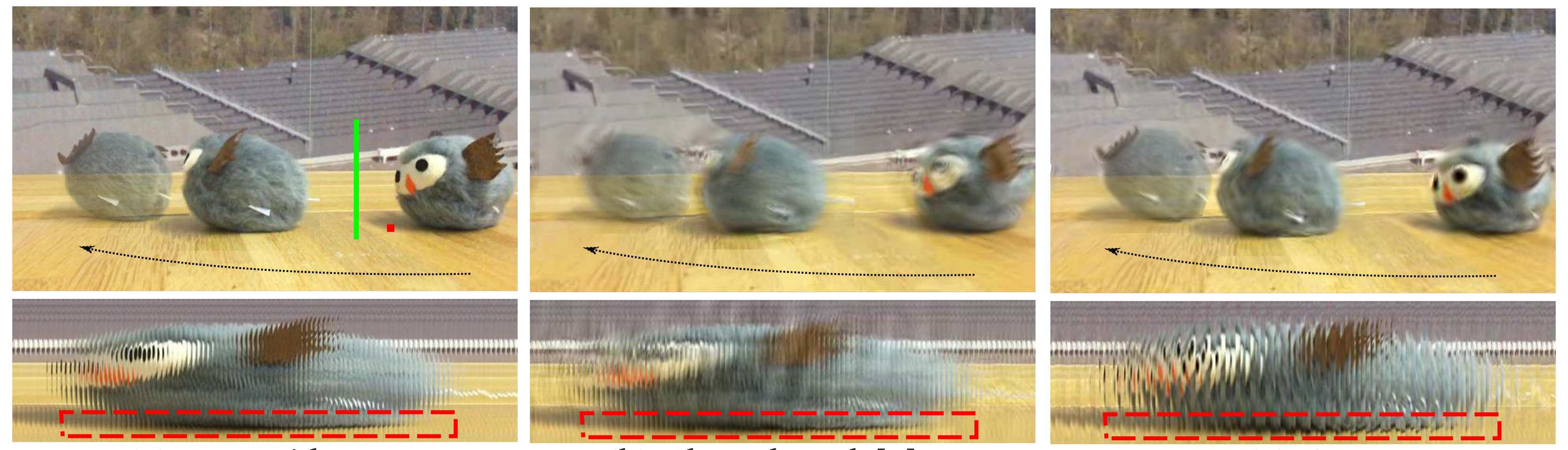
[1] M. A. Elgharib, et. al. Video magnification in presence of large motions. CVPR, 2015.

[2] N. Wadhwa, et. al. Phase-based video motion processing. SIGGRAPH, 2013.

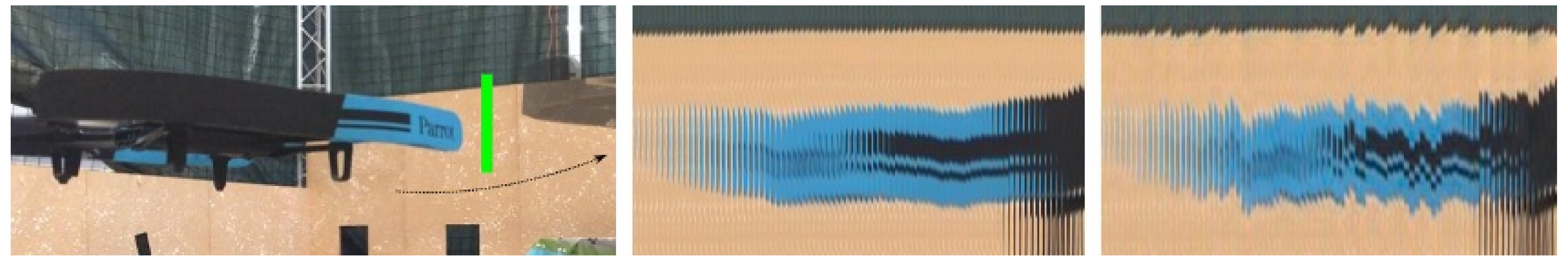
[3] H. Y. Wu, et. al. Eulerian video magnification for revealing subtle changes in the world. SIGGRAPH, 2012.

Project: https://acceleration-magnification.github.io.

Predictive maintenance (Cat-toy, Drone)



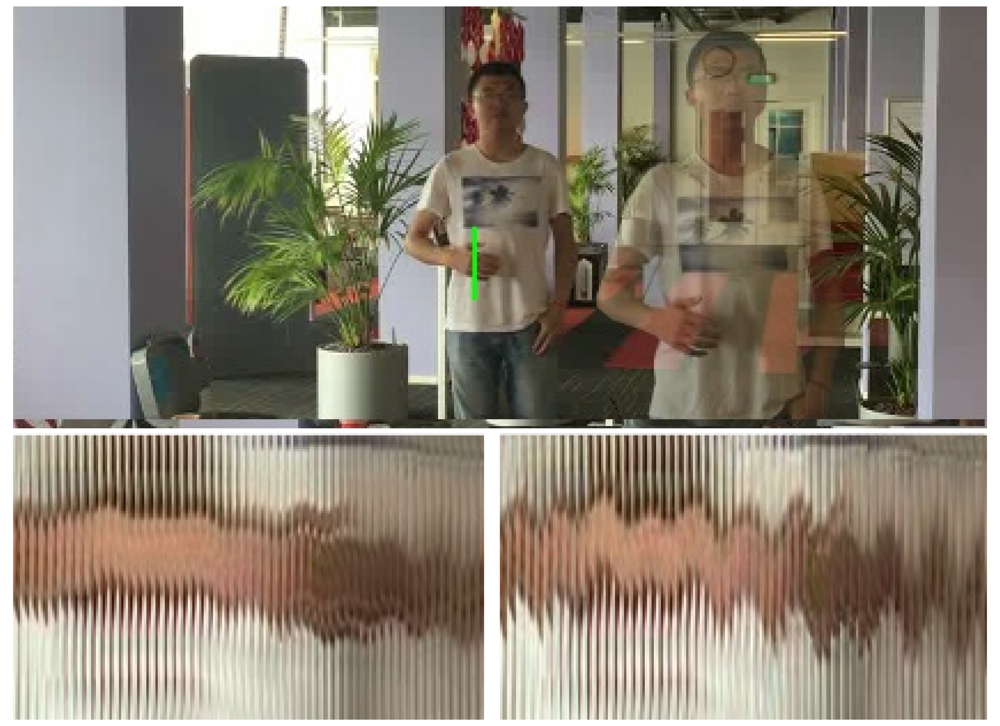
(a) Raw video. (b) Phase-based [2]. (c) Ours.



(a) Recording. (a) Raw video. (b) Ours.

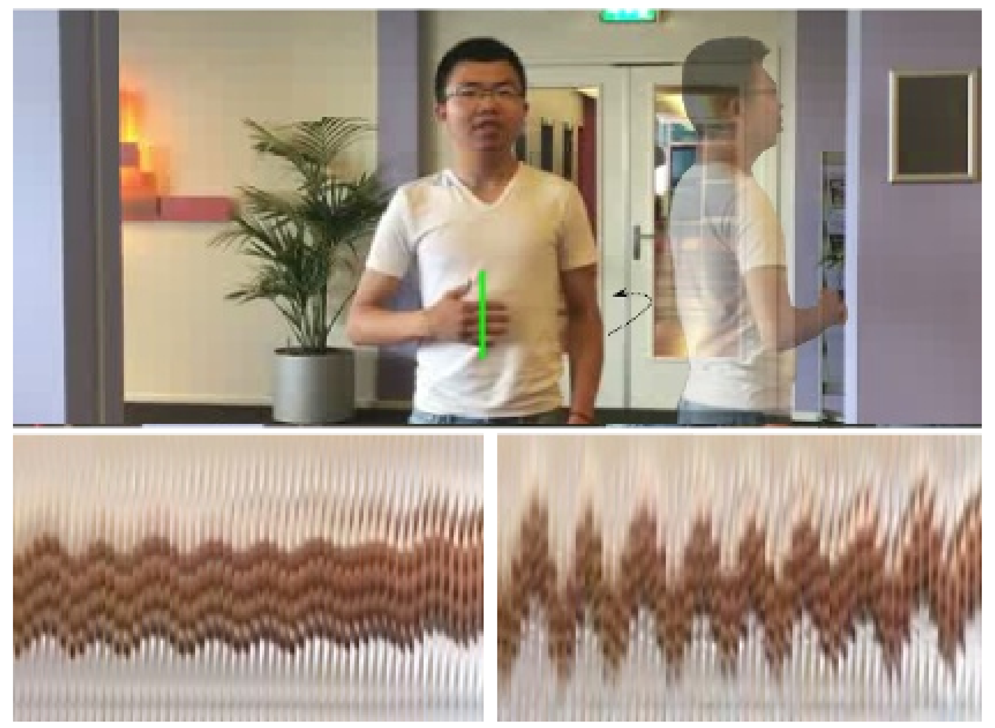
Medical domain (Parkinson-I, Parkinson-II)

Parkinson-I.



(a) Raw video. (b) Ours.

Parkinson-II.



(a) Raw video. (b) Ours.

Sports domain (Gun)

(a) Raw video. (b) Phase-based [2]. (c) DVMAG [1]. (d) Ours.