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Video Based Mice Seizure Detection

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Content

- Ideas to discuss
  - Dense optical flow is actually good
  - What are the shadows in the Eulerian magnified video?
  - Flow Difference
  - Flow Difference on a sparse grid
  - Stages of the FDM FFT

Dense optical flow is actually good

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- Suppose we define a small region of the image to compute a sparse flow
- The sparse flow computation will solve a minimization problem
- Even though we are computing flow for a small region, we do send the entire image to the algorithm
- Problem: a point inside the area of interest(small region) may be mapped to a point far a way from its previous known position.

Dense optical flow is actually good

- I'm looking for 20 points in a 10 km by 10 km square. At time t, point A is at position (0,0). At time t+Δt I see a point that looks like A, but at position (10,10)km. Because I'm only looking for 20 points and I'm a minimization algorithm, I'll say A moved from (0,0) to (10,10) in Δt.

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- Suppose now that I'm looking for 1 million points inside that same square. At time $t + \Delta t$ it is very unlikely that anyone moved from (0,0) to (10,10). Thus, I'll discard this possibility and say that point A must be near its previous known position. Even though there's a point at (10,10) that looks exactly like A at the previous time, I'll won't consider it to be A, because it is too far away.

Dense optical flow is actually good

The point is

We'll have less noise in optical flow computation if we use a dense grid.

What are the shadows in the magnified video?

- For a fixed pixel (i, j) in the image, plot its intensity value as a discrete function $I_{i,j}(k)$ in the interval of interest of length T. You'll have $N = \frac{T}{\Delta T}$ points to plot, ΔT being the sampling time

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- This function can be decomposed into a sum of N sinusoidals inside the interval of interest

$$I_{i,j}(k) = \sum_{L=0}^{N-1} a_L \cos(\frac{2\pi}{N} Lk) + b_L \sin(\frac{2\pi}{N} Lk) \tag{1}$$

What are the shadows in the magnified video?

- Or, in complex exponential form

$$I_{(i,j)}(k) = \sum_{L=0}^{N-1} d_L e^{j\frac{2\pi}{N}Lk} \tag{1}$$

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- The d_L coefficients can be computed with the discrete Fourrier Transform.
- Part of Eulerian magnification consists in applying a frequency filter the change de d_L coefficients as a function of L. The idea is to increase those coefficients so high frequency components are more obviously noted.

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- In openCV, for example, any value of pixel higher than 255 is set to 255. That is, 255 is the value for the brightest white, and nothing can be set brighter than the brightest white.
- Our new function, after the magnification, is thus:

$$E_{i,j}(k) = min(\sum_{L=0}^{N-1} G(L) d_L e^{j\frac{2\pi}{N}Lk}, 255) \tag{2}$$

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- On the other hand, we cannot get darker than the darkest black(pixel value = 0)
- Thus, we correct again:

$$E_{i,j}(k) = max(0, min(\sum_{L=0}^{N-1} G(L) d_L e^{j\frac{2\pi}{N}Lk}, 255)) \qquad (2)$$

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- I propose that the shadows we're observing is a result of the saturations of the system. The gain being applied is so high that any slight increase in intensity value produces a bright white and any slight decrease produces a dark black.
- When a mouse(white object) moves from A to B, point A becomes darker because it no longer holds a white pixel and point B holds now something brighter than previously it did. Due to saturation, A becomes black and B becomes white
- Ideally, only a pixel belonging to the fastest movement in the video should be mapped to 255.

Solving shadows

Solution

Reduce frequency gain in order to avoid saturation.

Flow Difference

This is Flávio's approach to study the seizure

- Our previous idea was that the flow field of a seizure event would have a high frequency component.
- The new approach is based on that same assumption, we simply use a different way of looking at it
- First we compute the vectorial difference between two consecutive flows. This correspond, in some sense I'm sure, to the temporal second derivative of the image.
- We now construct an image with the magnitude of the flow difference at each point
- We take the 2 dimensional Fourrier Transform of this image.

Flow Difference

- Vidal says that during seizures, it will be easy do detect high frequency by looking at points of the magnitude spectrum distant from the origin.

Flow Difference

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- The problem of a sparse grid is that you'll have a flow difference magnitude image with spikes: it can only be different than zero in points where you actually computed the flow.
- Experimentally(and it reminded me of results in one dimensional FFT, and I'm sure this is can be shown for two dimensional) by running FFT on a 2 dimensional image with spikes here and there, you get a FFT that has spikes over the entire spectrum. I feel it is also periodic.

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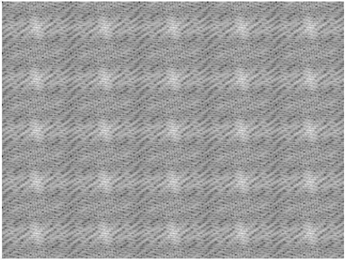
- More experiments are required before we can drawn any conclusion.

Conclusion

Dr. Vidal proposed a methodology based on 2 dimensional fourrier transform of the flow difference. The method is computationally heavy and needs more results so we evaluate if it is worth the trouble.

Flow Difference on a sparse grid

Those are samples of the FFT obtained when setting the flow to a sparse grid. We notice periodicity in the spectrum.



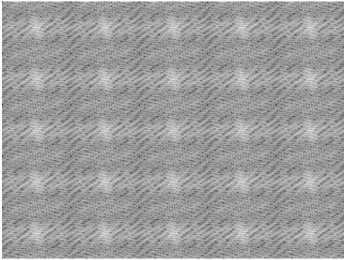


Figure : FFT of the magnitude of the flow difference where flow was computed on a sparse grid containing one every 5 pixels both in x and y.

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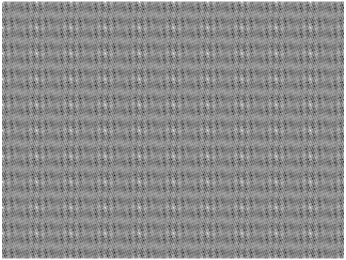

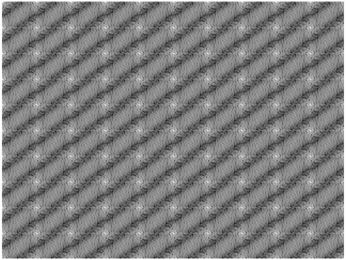

Figure : This time the spacing is of 10.

Stages of the FDM FFT

Some pictures to illustrate discussion.

Figure : The magnitude of flow difference at each point.

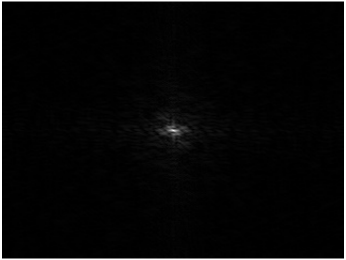

Figure : The FFT of the previous image