

# Assignment 6

OPTIC FLOW

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## 1) Lucas Kanade Optic Flow

### a) Small motion

I used a Gaussian filter of size 25-by-25 pixels with a sigma of 15.

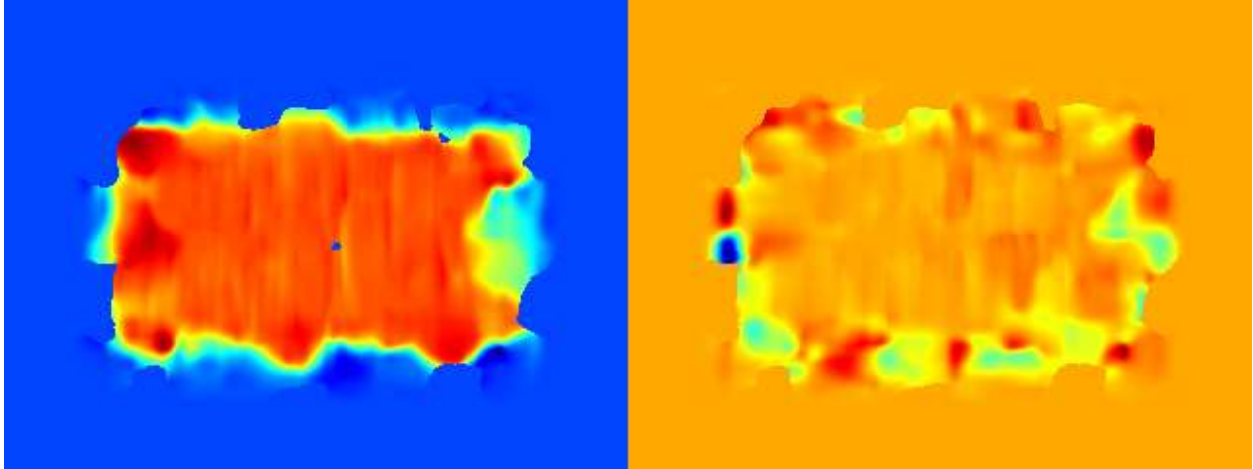


Figure 1: ps6-1-a-1.png

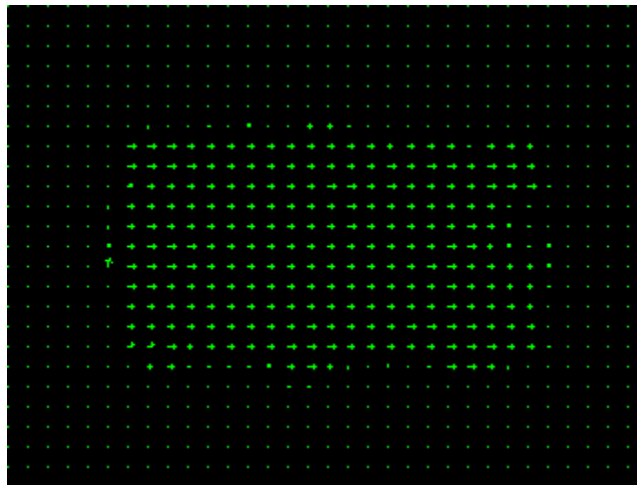


Figure 2: ps6-1-a-1 quiver plot

I had to use a pretty large window size (61) to get the smooth results below.

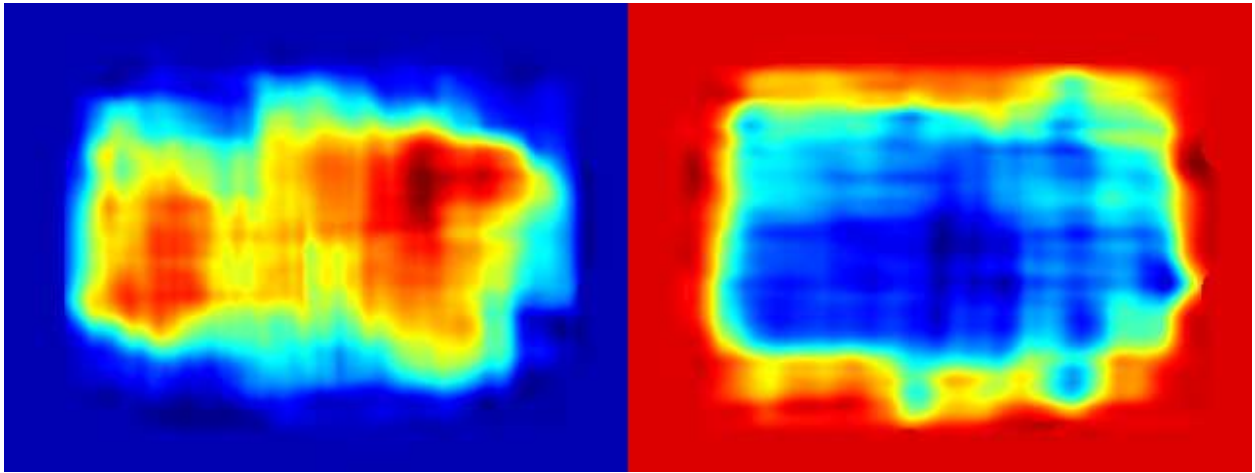


Figure 3: ps6-1-a-2.png

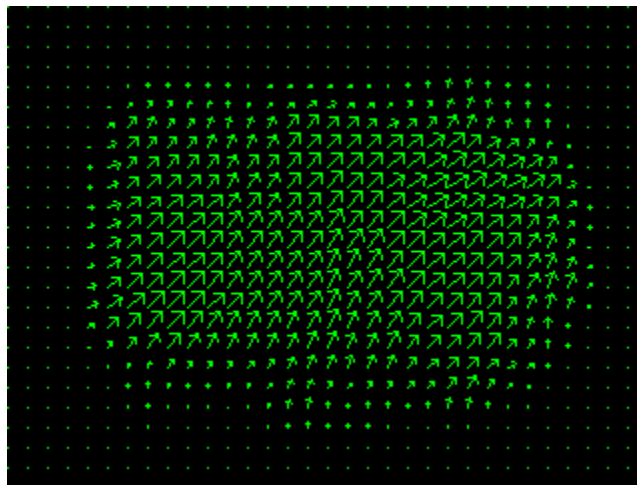


Figure 4: ps6-1-a-2 quiver plot

b) Large motion

For the smaller motion displacement (see Figure 5 and Figure 6) the results are as expected. The flow is consistent within the motion region.

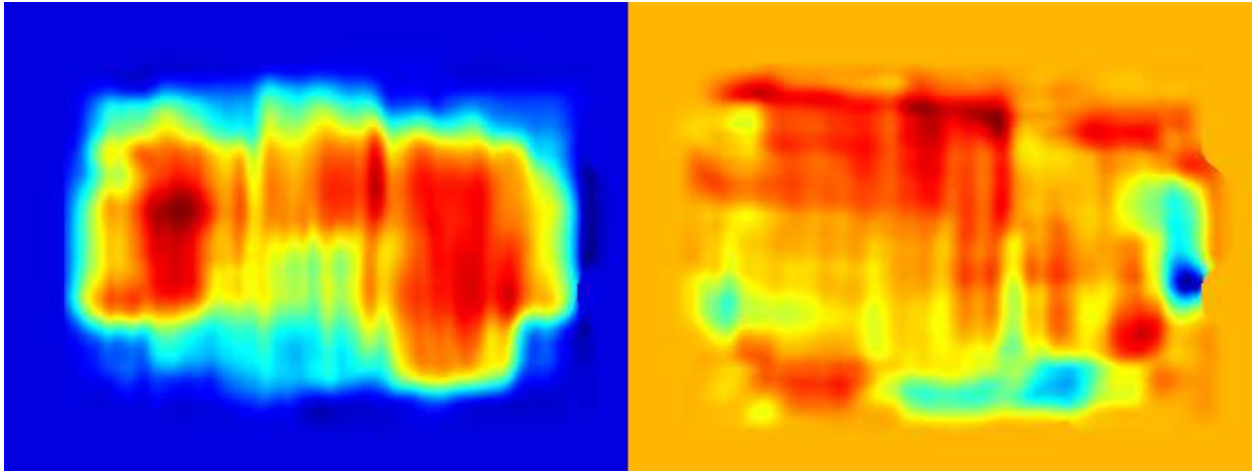


Figure 5: ps6-1-b-1.png

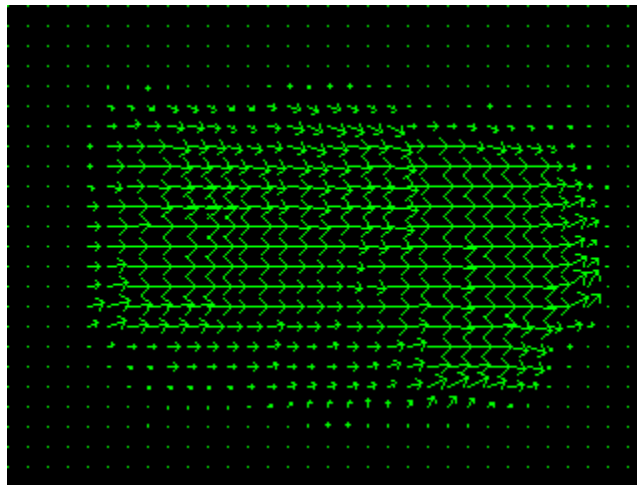
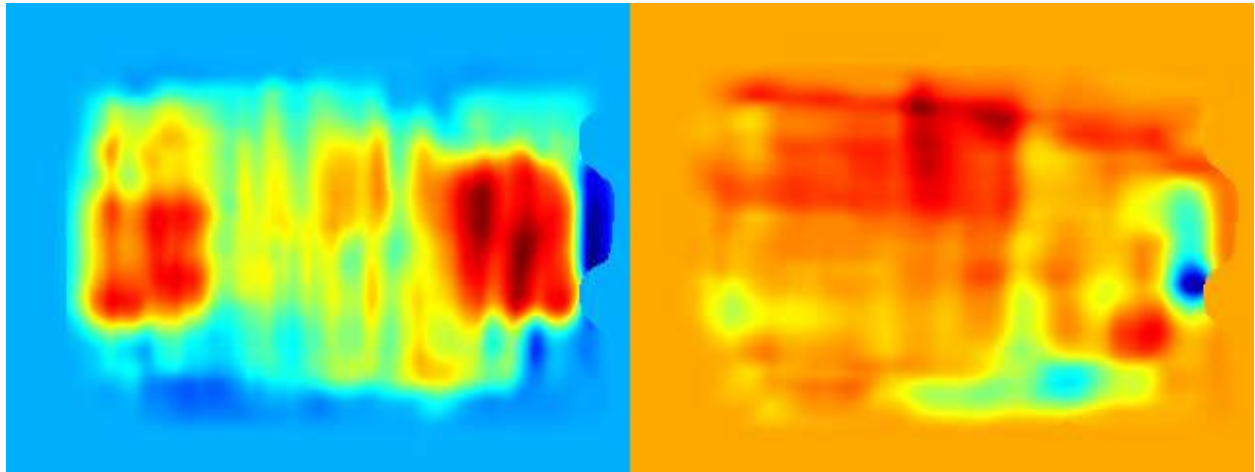
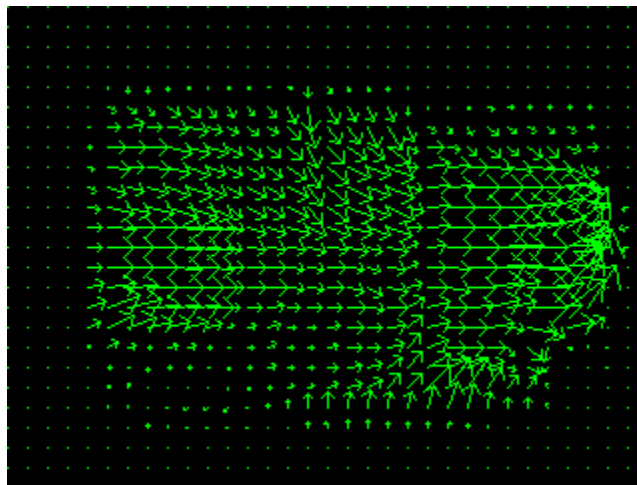


Figure 6: ps6-1-b-1 quiver plot

As the size of the motion increases, the results become increasingly noisy. For the displacement of 20 pixels (Figure 7 and Figure 8) the flow is still consistent in the motion region, but boundary effects start to come into play.



*Figure 7: ps6-1-b-2.png*



*Figure 8: ps6-1-b-2 quiver plot*

For the displacement of 40 pixels (Figure 9 and Figure 10) the results are almost entirely dictated by the boundary effects. There is almost none of the actual displacement captured in the output.

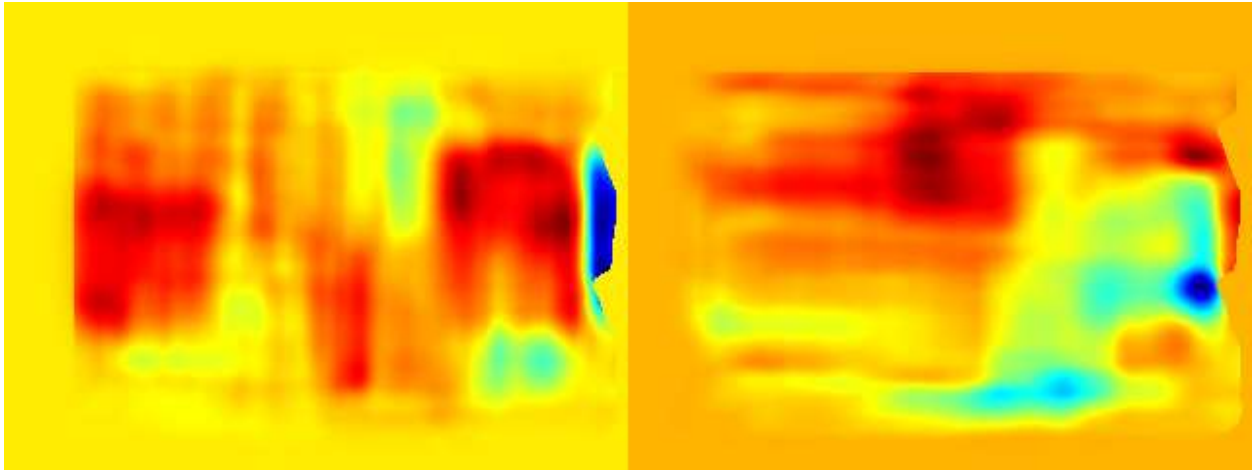


Figure 9: ps6-1-b-3.png

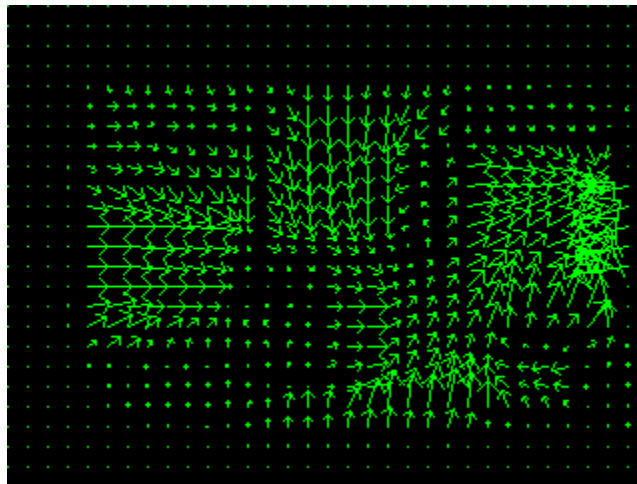


Figure 10: ps6-1-b-3 quiver plot

## 2) Gaussian and Laplacian Pyramids

a) Reduce

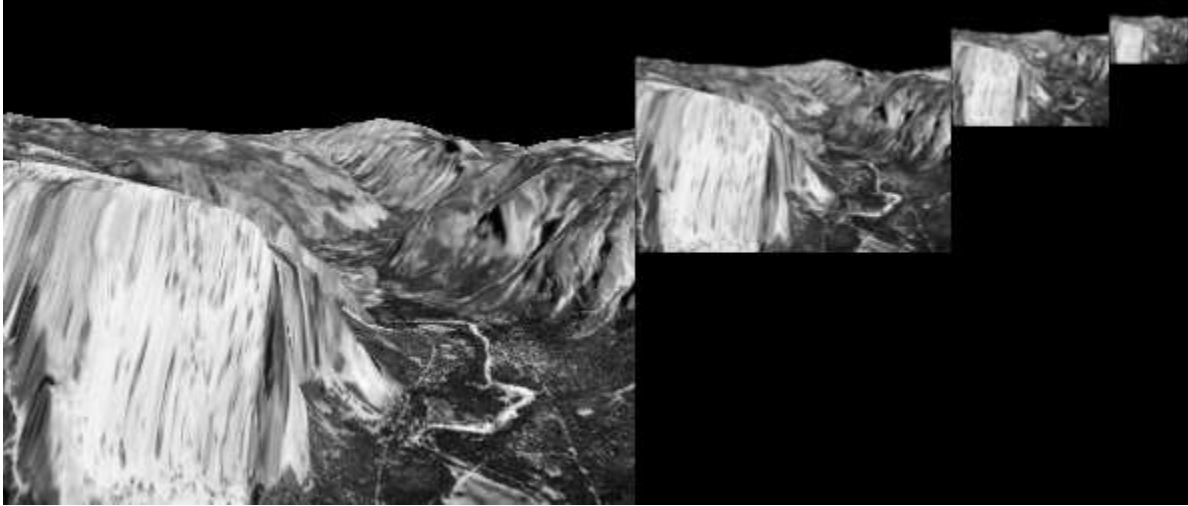


Figure 11: ps6-2-a-1.png

b) Expand

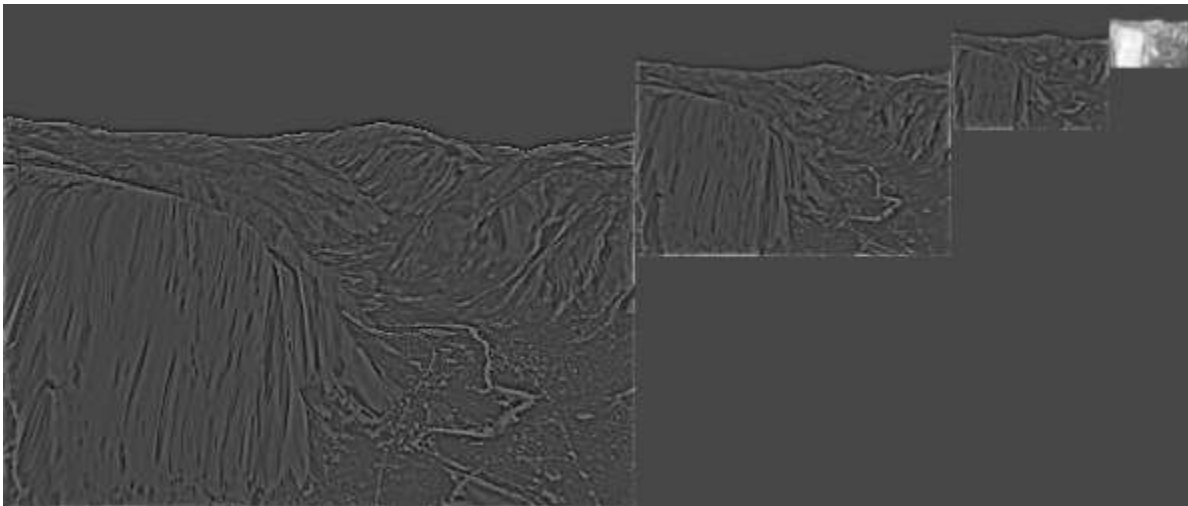


Figure 12: ps6-2-b-1.png

### 3) Warping by flow

#### a) Single level

I think the quiver plot is more telling here. You can see a lot of motion in the foreground and virtually no motion in the background. I used pyramid level 1 (the second from the bottom) for this image sequence.

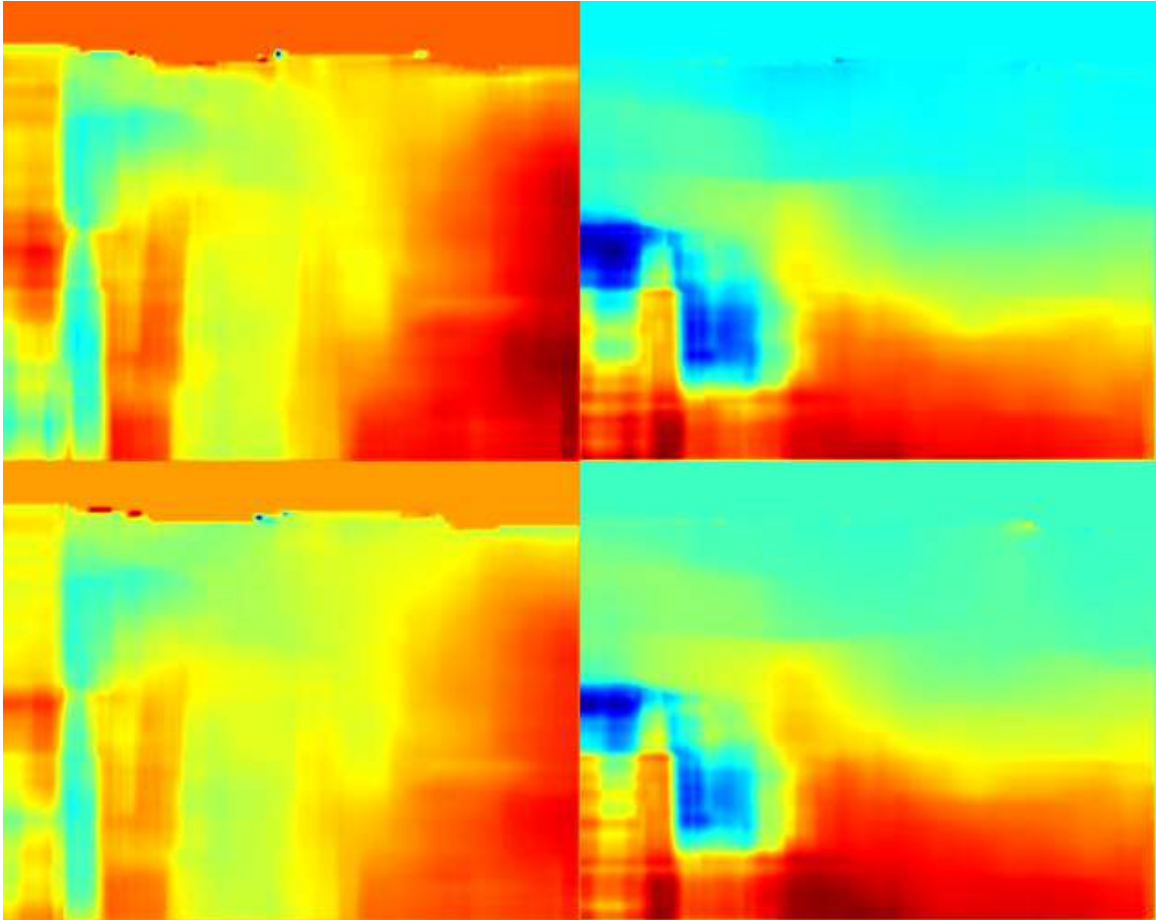


Figure 13: ps6-3-a-1.png



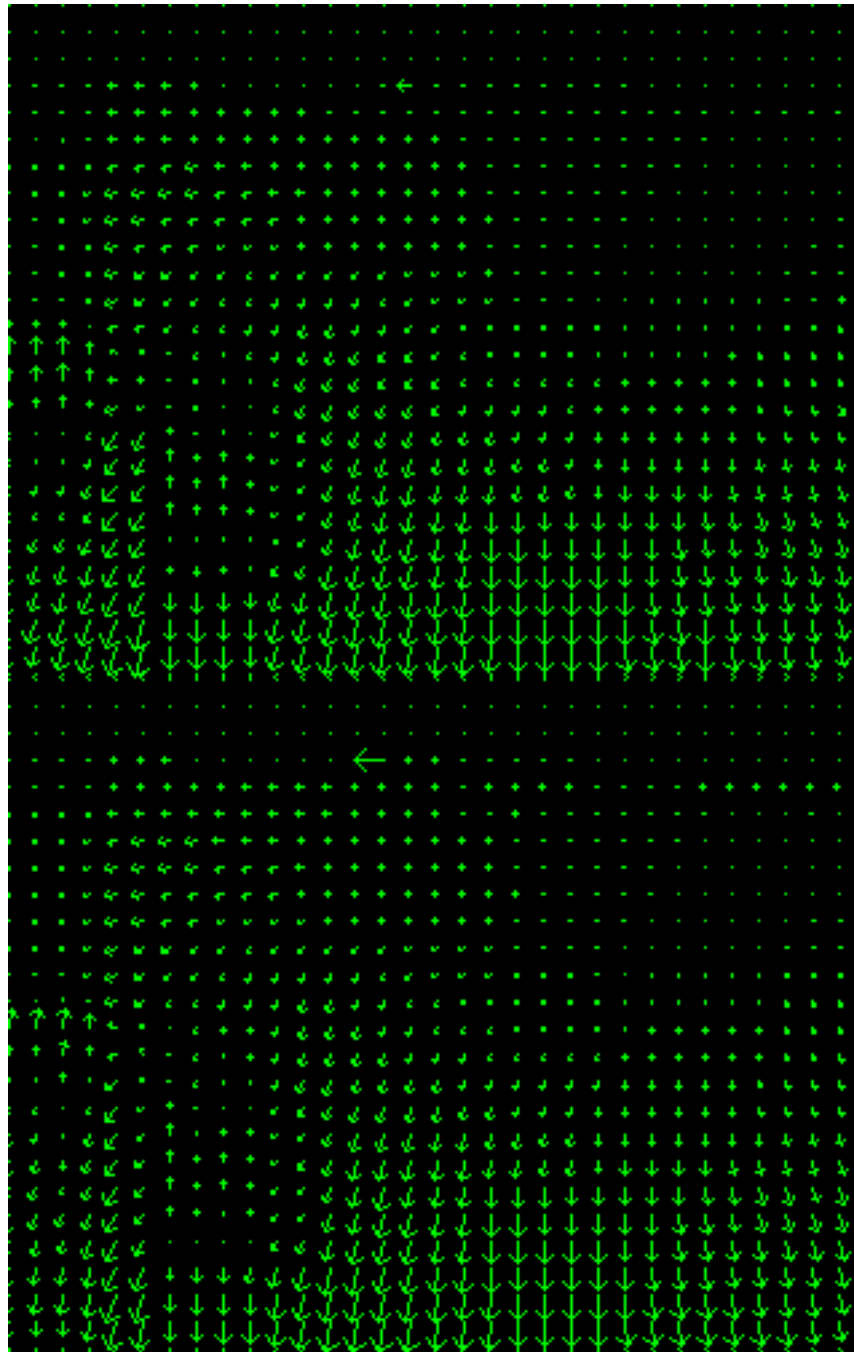
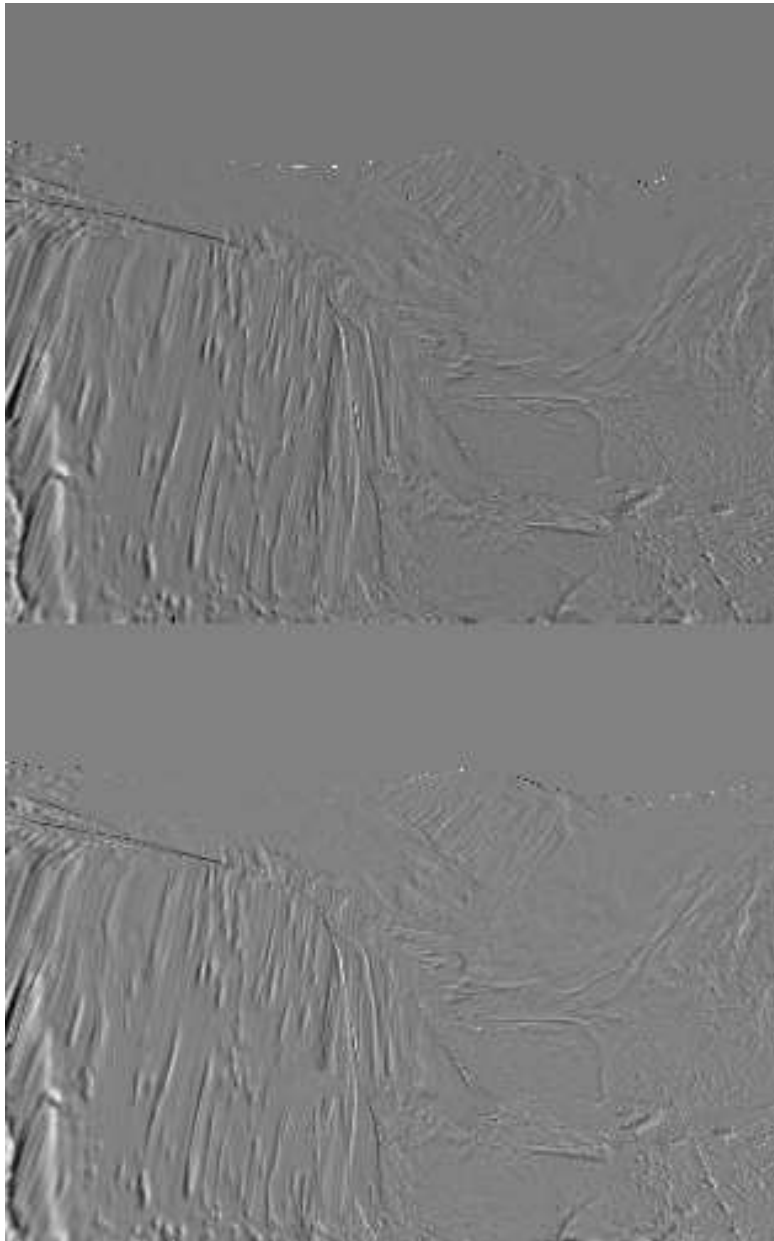


Figure 14:  $ps6-3-a-1$  quiver plot

The difference image isn't perfect, but does seem to be similar to what other people have been posting on the forums. I tried some of the recommendations to get better results, but this was the best I could get.



*Figure 15: ps6-3-a-2.png*

For the second sequence, I used pyramid level 3 to get the smoother flow.

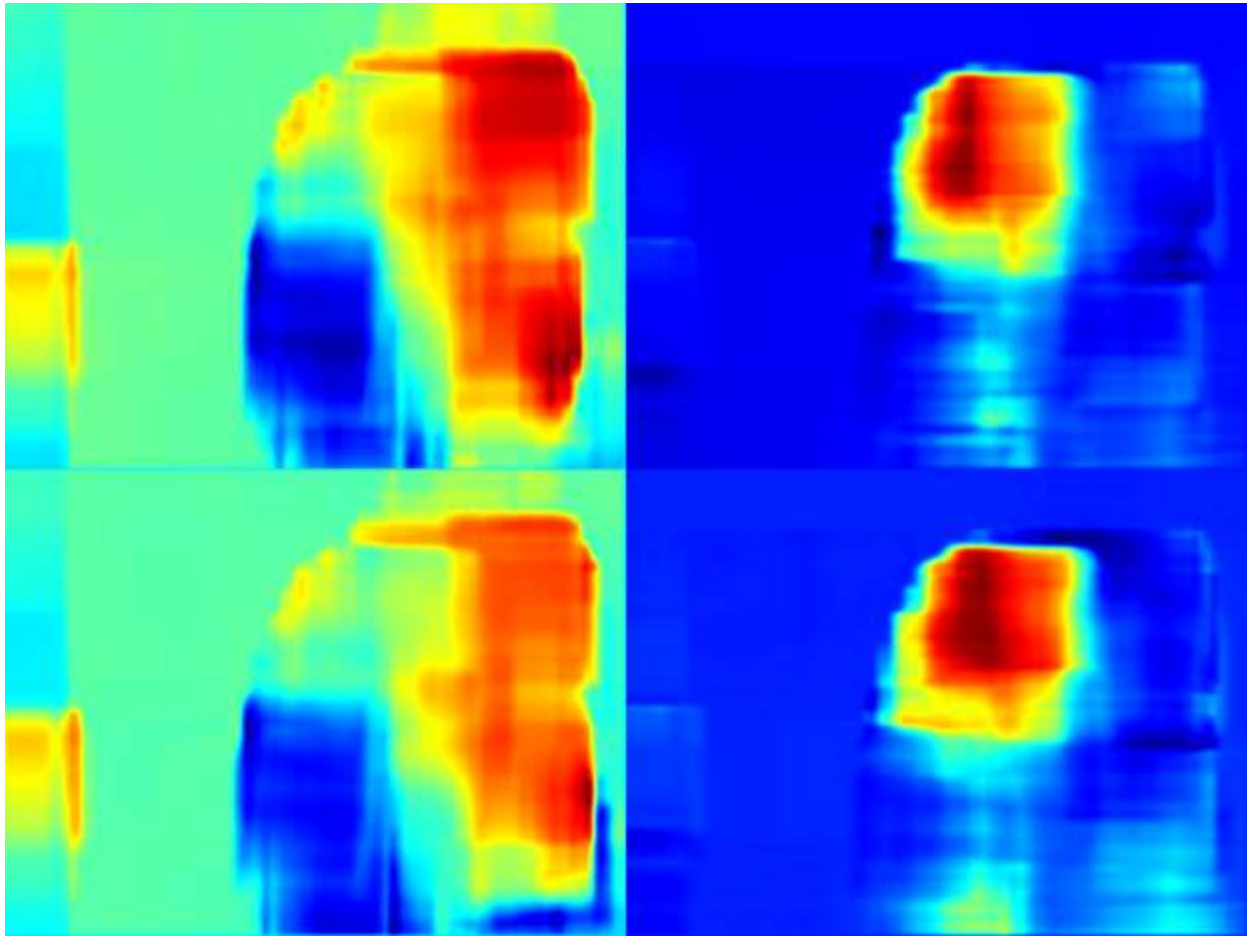


Figure 16: ps6-3-a-3.png

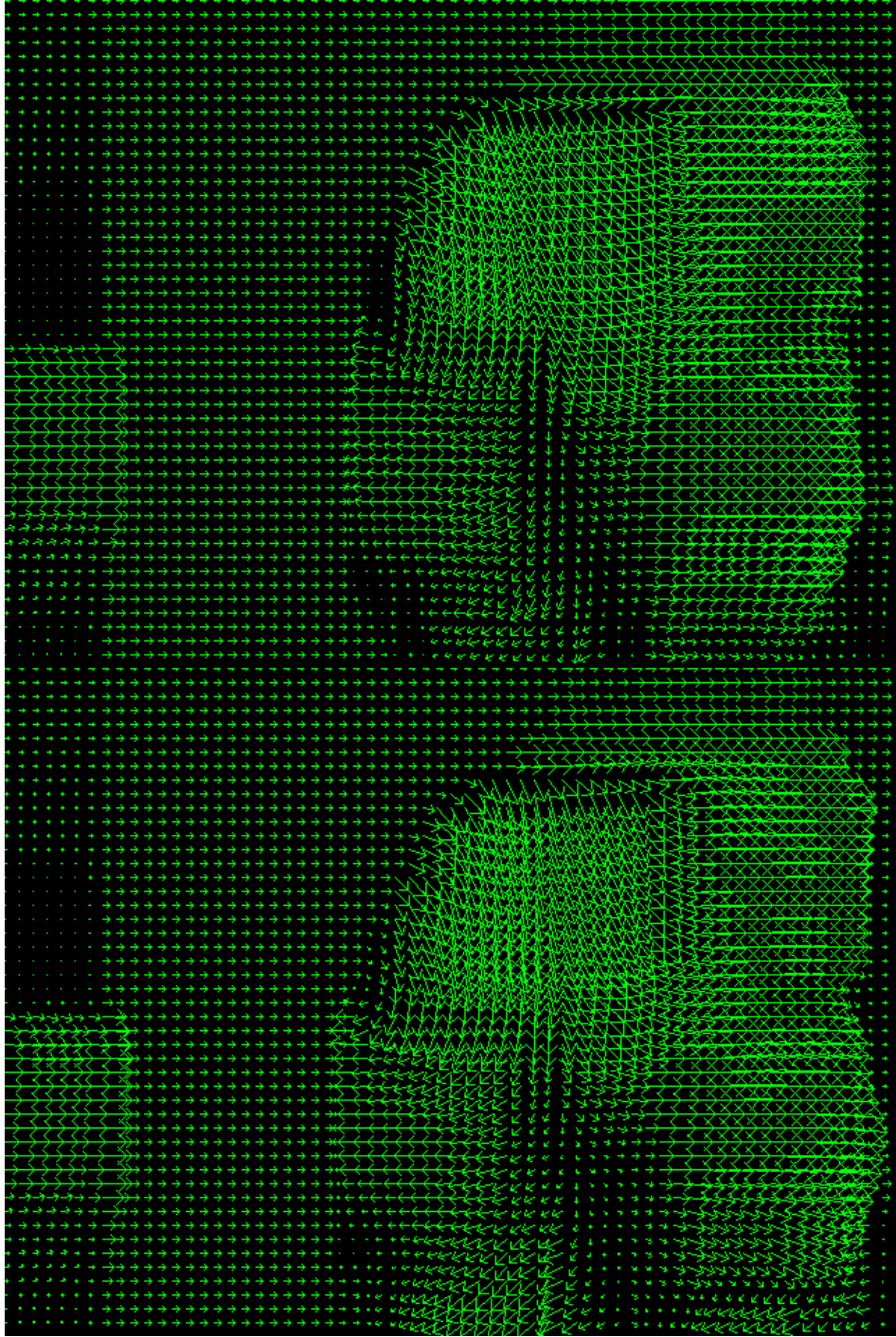


Figure 17: ps6-3-a-3 quiver plot

Again, the difference images aren't perfect (ideally it should have no variation), but it was the best I could manage after lots of tweaking. The flow from above seems correct, so it might just be a scaling issue.

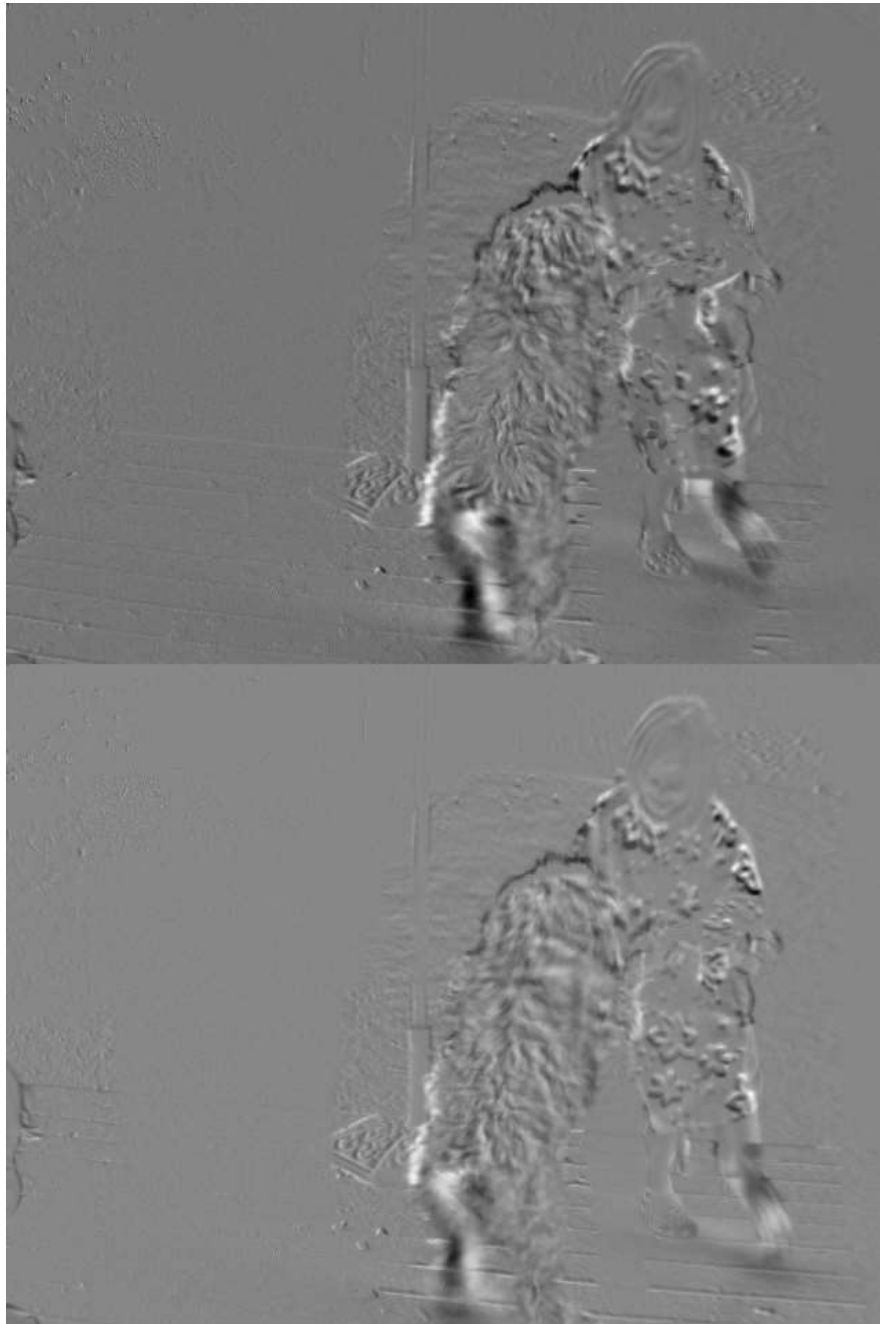


Figure 18: ps6-3-a-4.png

#### 4) Hierarchical LK Optic Flow

I tried Gaussian smoothing on some of the sequences here, but the results did not seem to improve much. I believe this is reasonable since hierarchical LK will downsample first, which should reduce some of the noise much like Gaussian smoothing does. In general, I believe the flows to be correct (see the quiver plots), but there might be been a scaling issue for some because the difference images are not as gray as preferred.

a) First sequence – Large motion

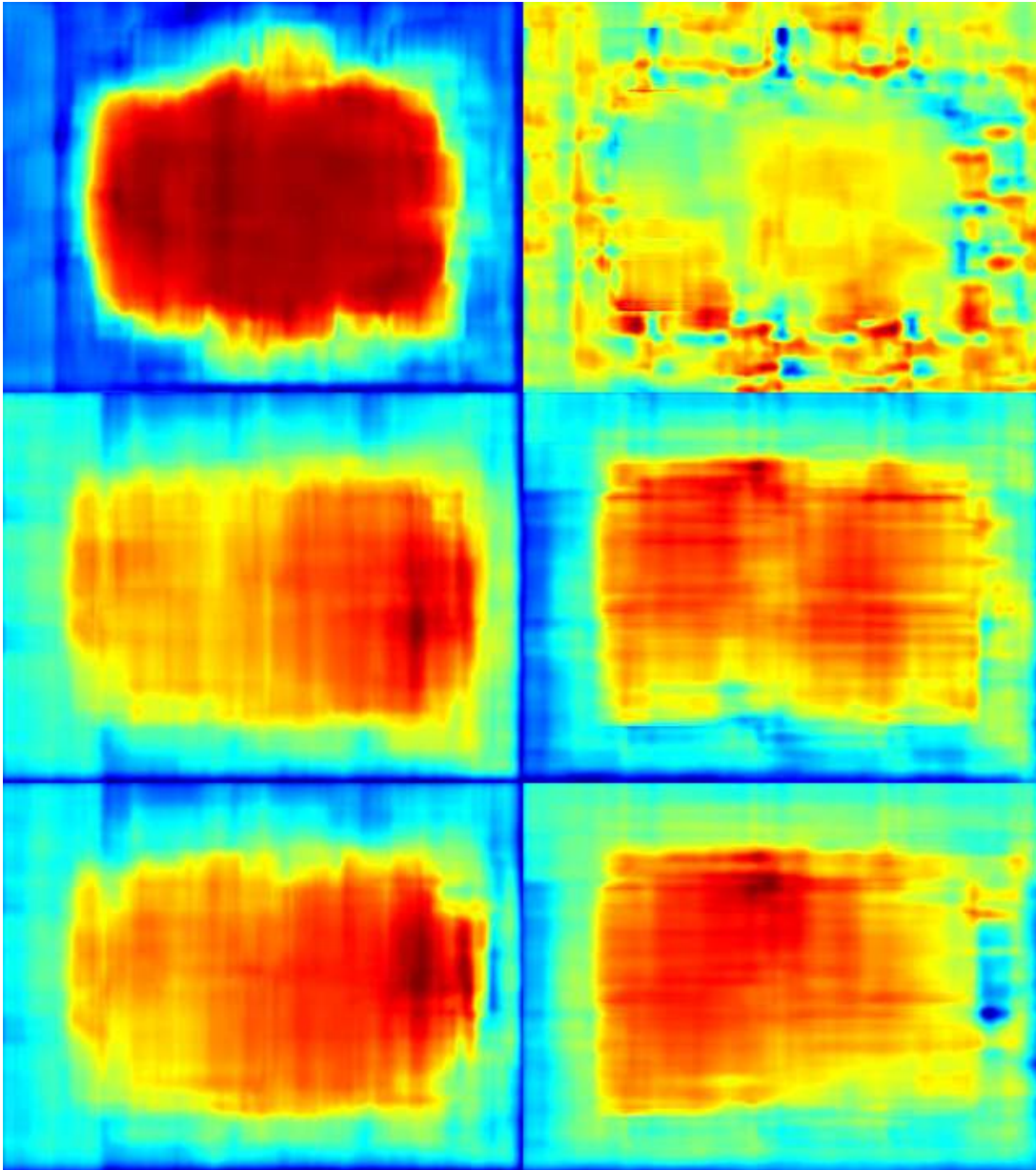


Figure 19: ps6-4-a-1.png

The flow looks correct for the 10 pixel displacement, but starts to look off for the 20 and 40 pixel displacements. However, the 20 and 40 displacements look significantly better than before without using the hierarchical LK method.

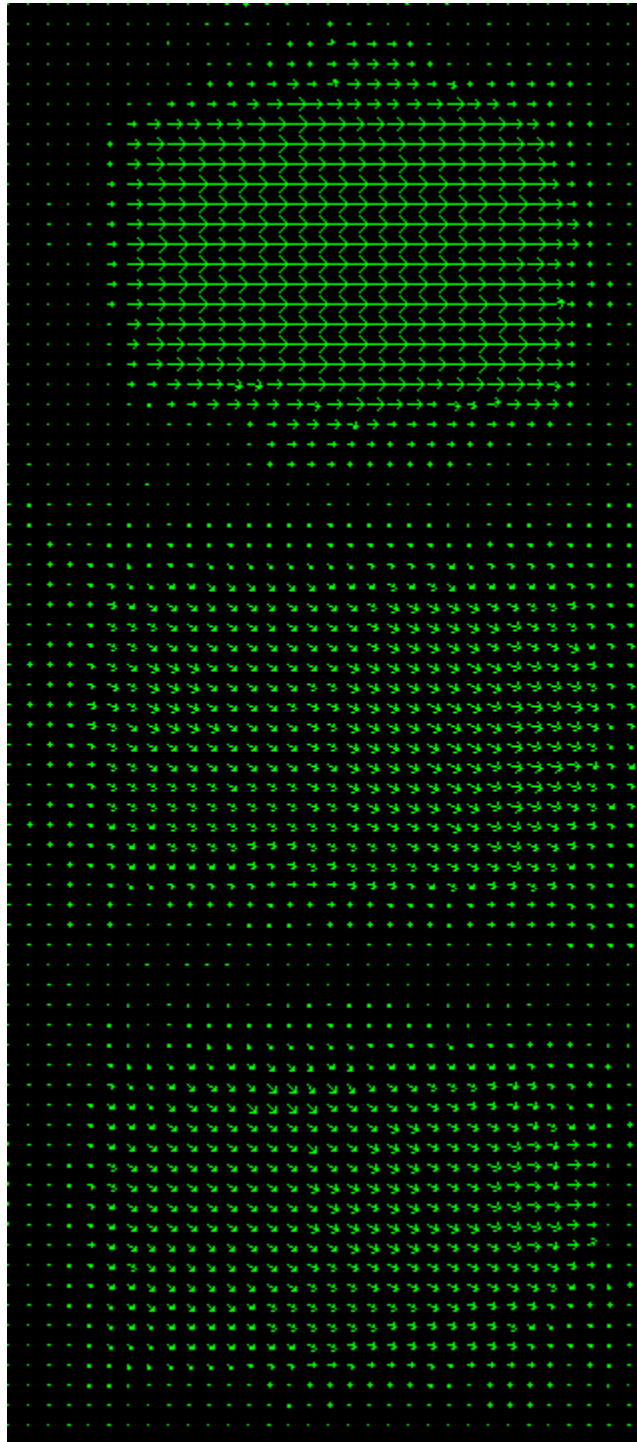


Figure 20: ps6-4-a-1 quiver plot



I know there is a scaling issue here. For the 10 pixel displacement, I could not have gotten better results. There are some boundary and noise effects going on here, but the motion region is warped almost perfectly back. This was done without scaling the flow values. For the 20 and 40 pixel displacements, the results were not as good. I did not scale the flow displacement values here because I wanted to show that hierarchical LK does not work for large displacements. Since the 10 pixel displacement worked fine, I knew that the code was functioning properly. I tried scaling the flow values to the proper ranges (0 to 20 and 0 to 40 respectively). I got results similar to the 10 pixel displacement for the motion region. However, I also got significantly more noise in the non-motion region. (The small displacement noise that would normally be filtered out here was magnified since everything was scaled up.) I decided to not scale the flow values here to show the deficiencies of hierarchical LK with large displacement.

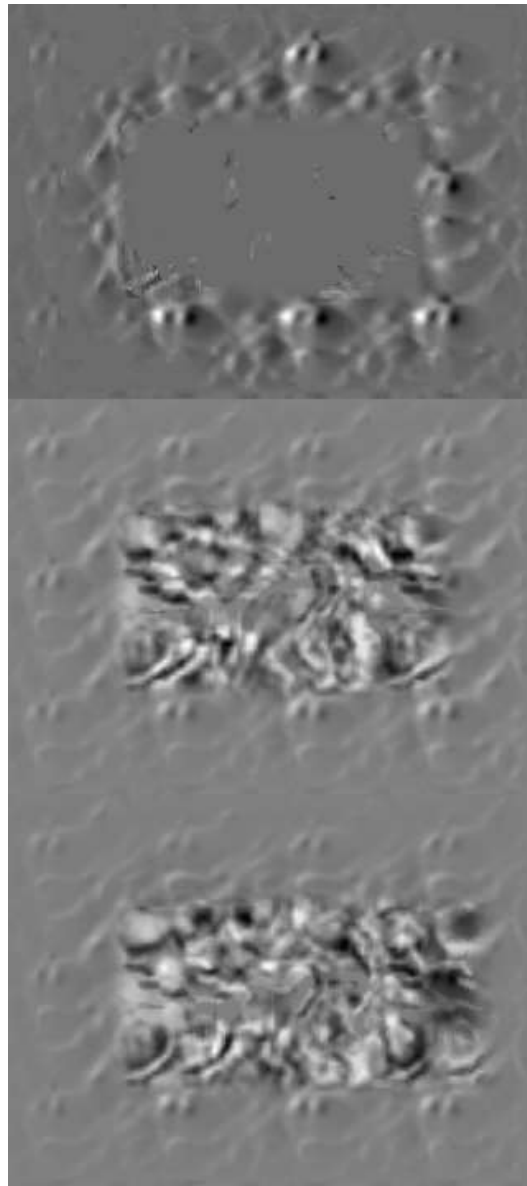


Figure 21: ps6-4-a-2.png



b) Second sequence - Yosemite

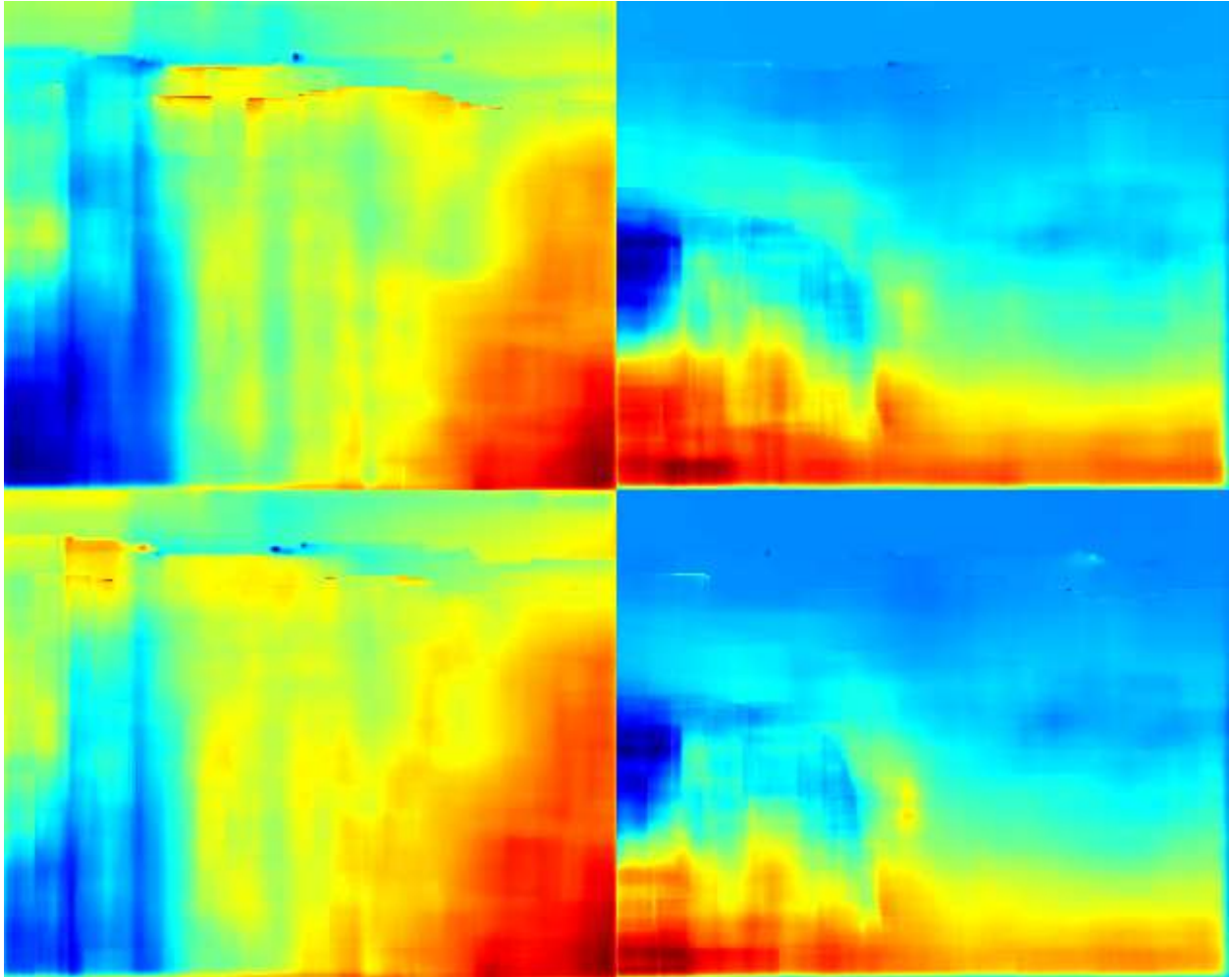


Figure 22: ps6-4-b-1.png

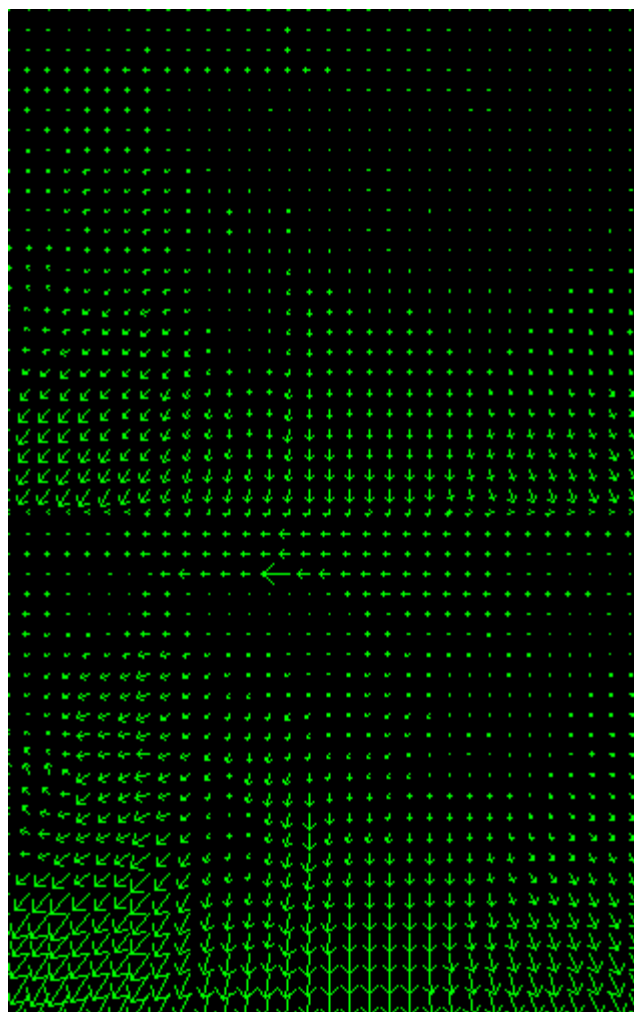


Figure 23: ps6-4-b-2 quiver plot

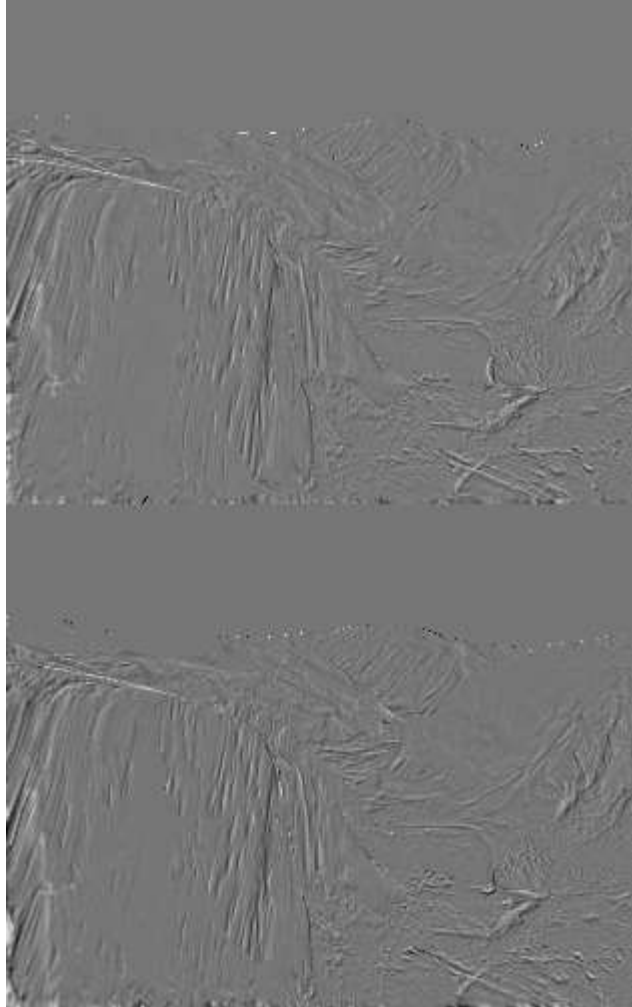


Figure 24: ps6-4-b-2.png

c) Third sequence – Girl and Dog

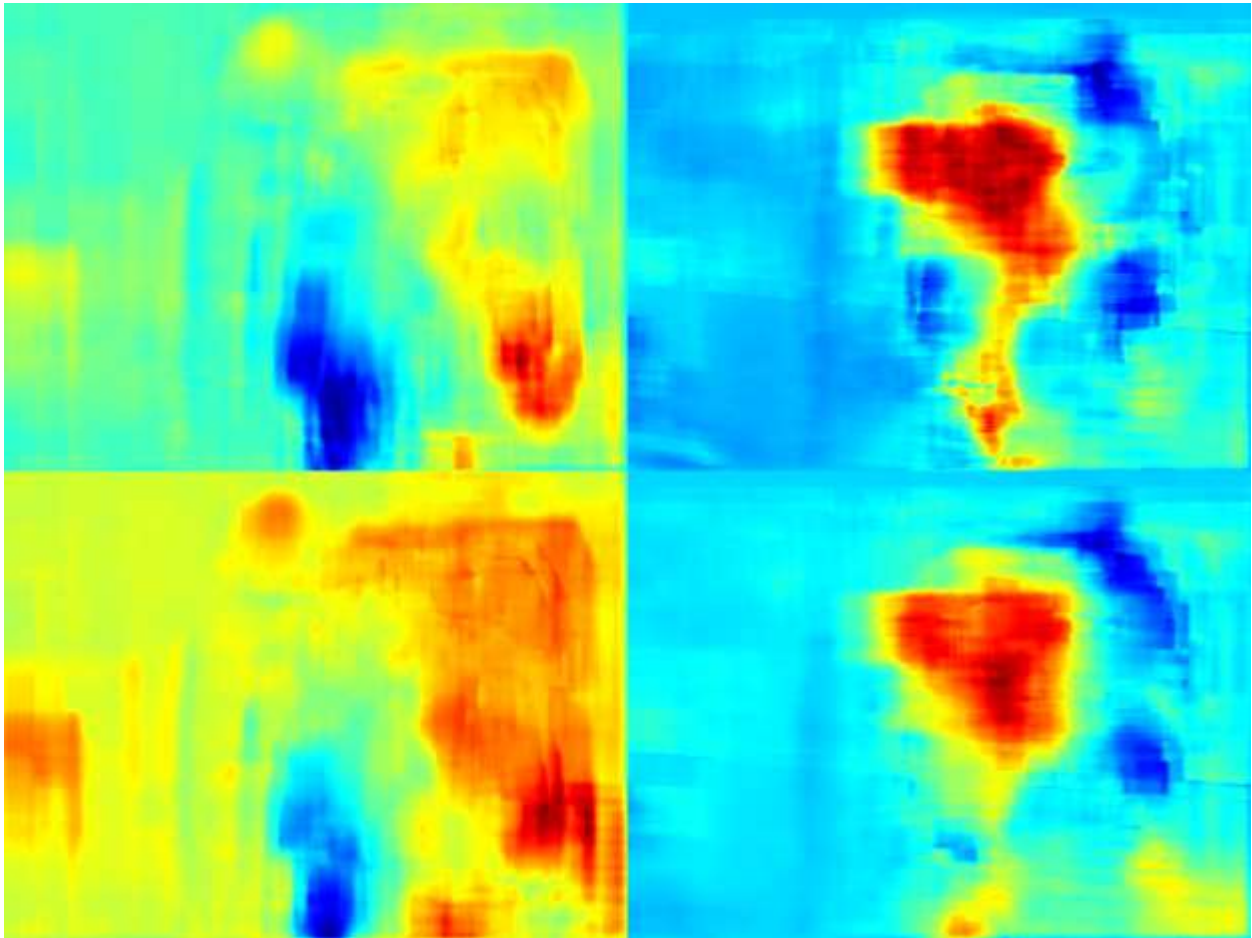


Figure 25: ps6-4-c-1.png

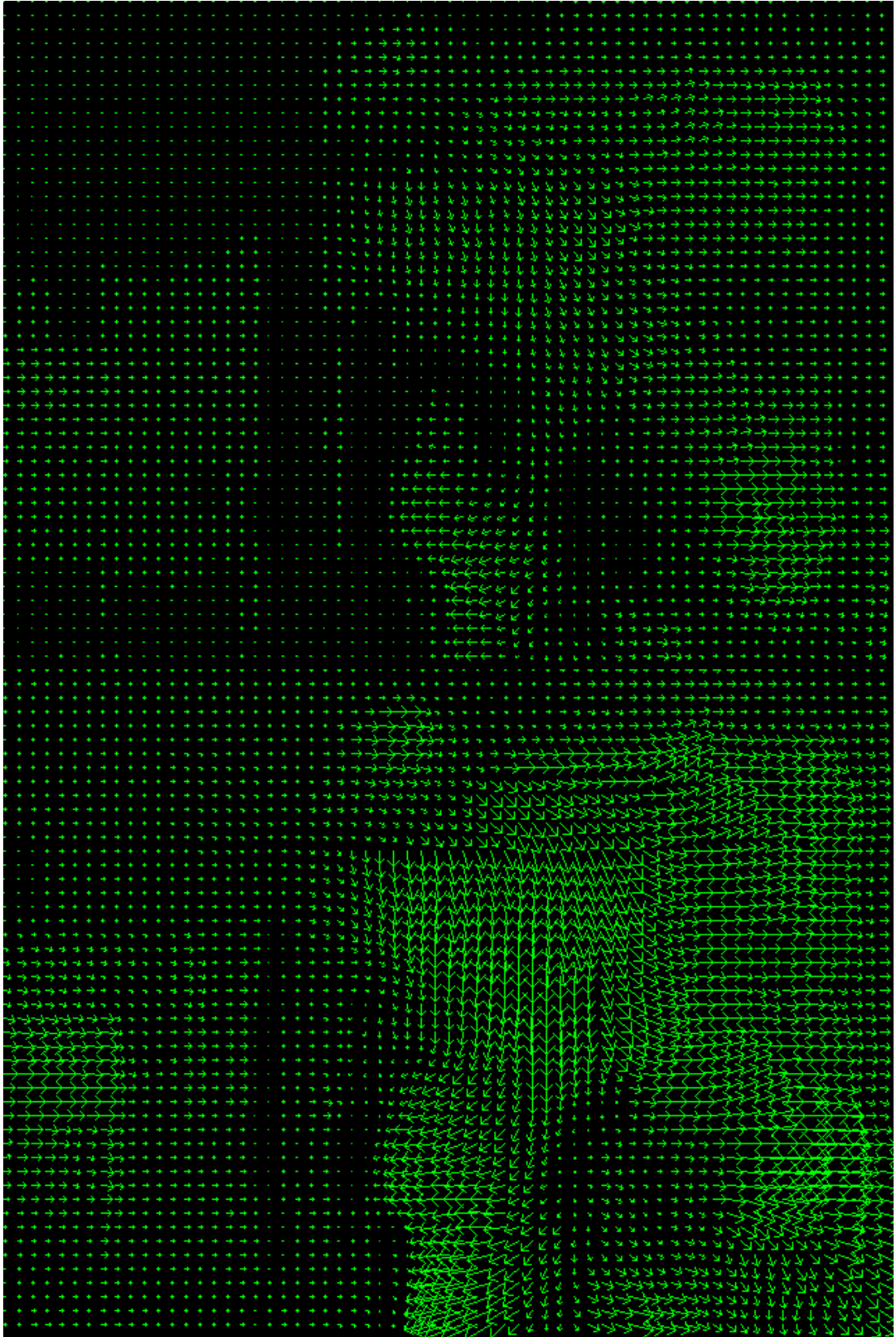


Figure 26: ps6-4-a-1 quiver plot

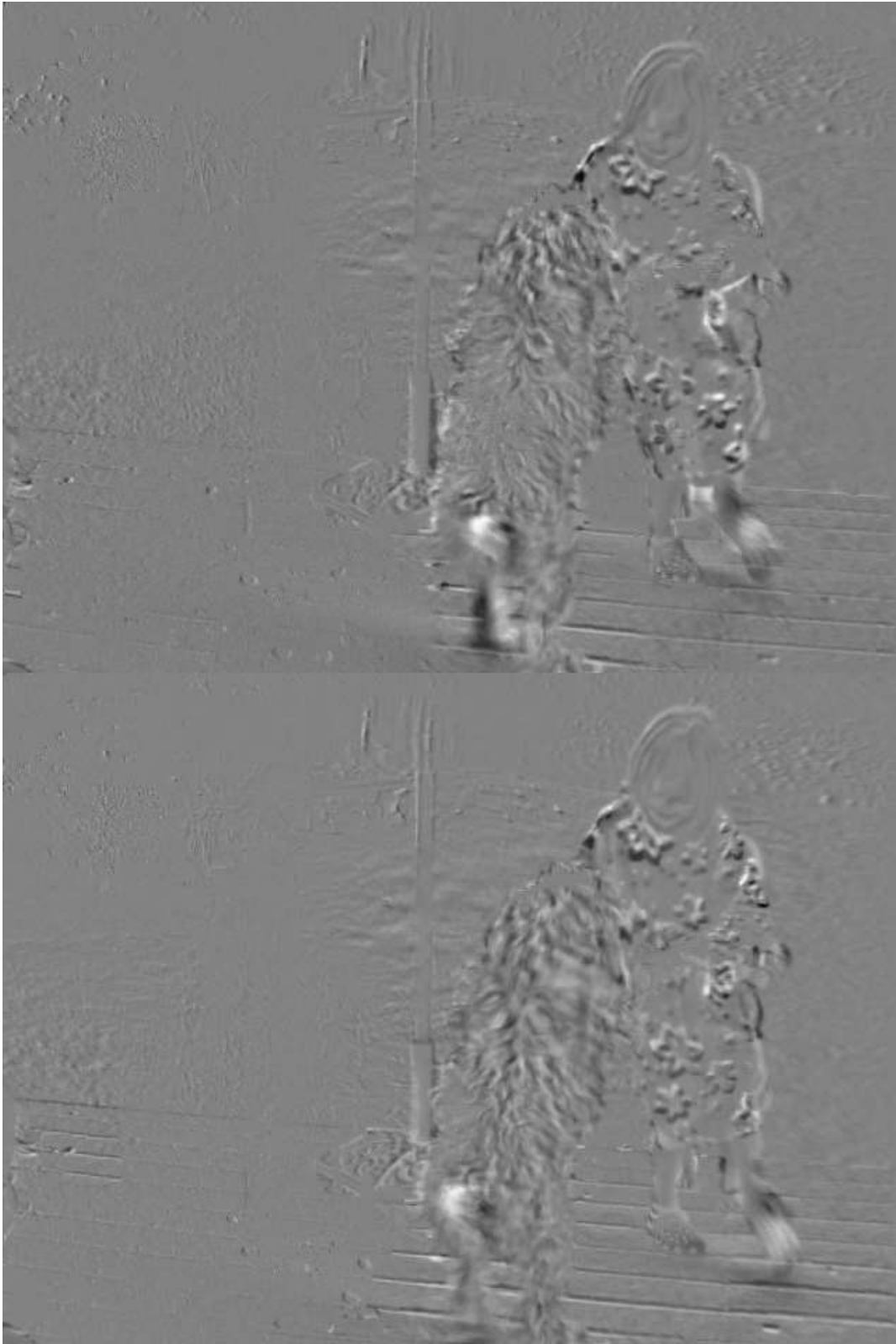


Figure 27: ps6-4-c-2.png



## 5) Juggle sequence

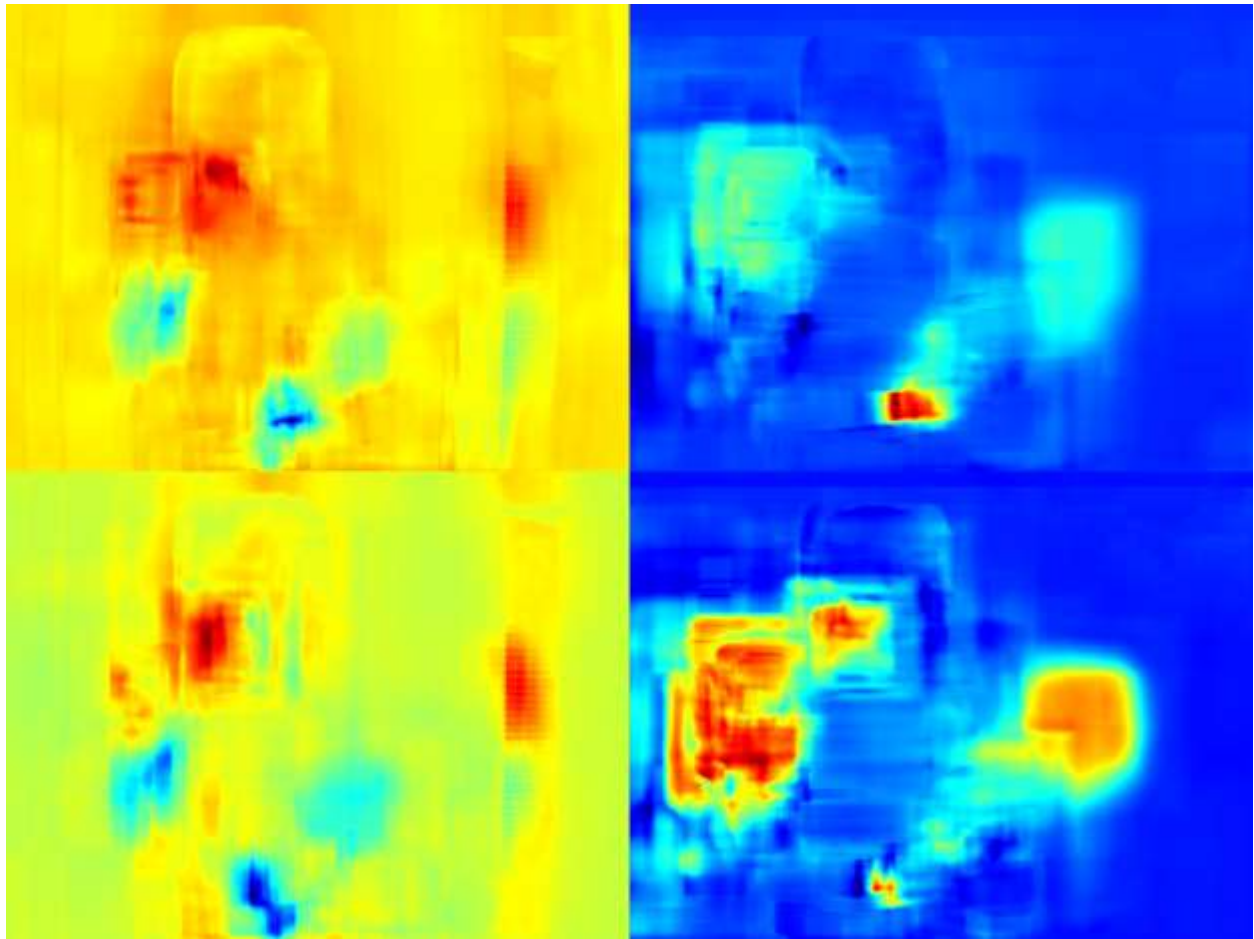


Figure 28: ps6-5-a-1.png

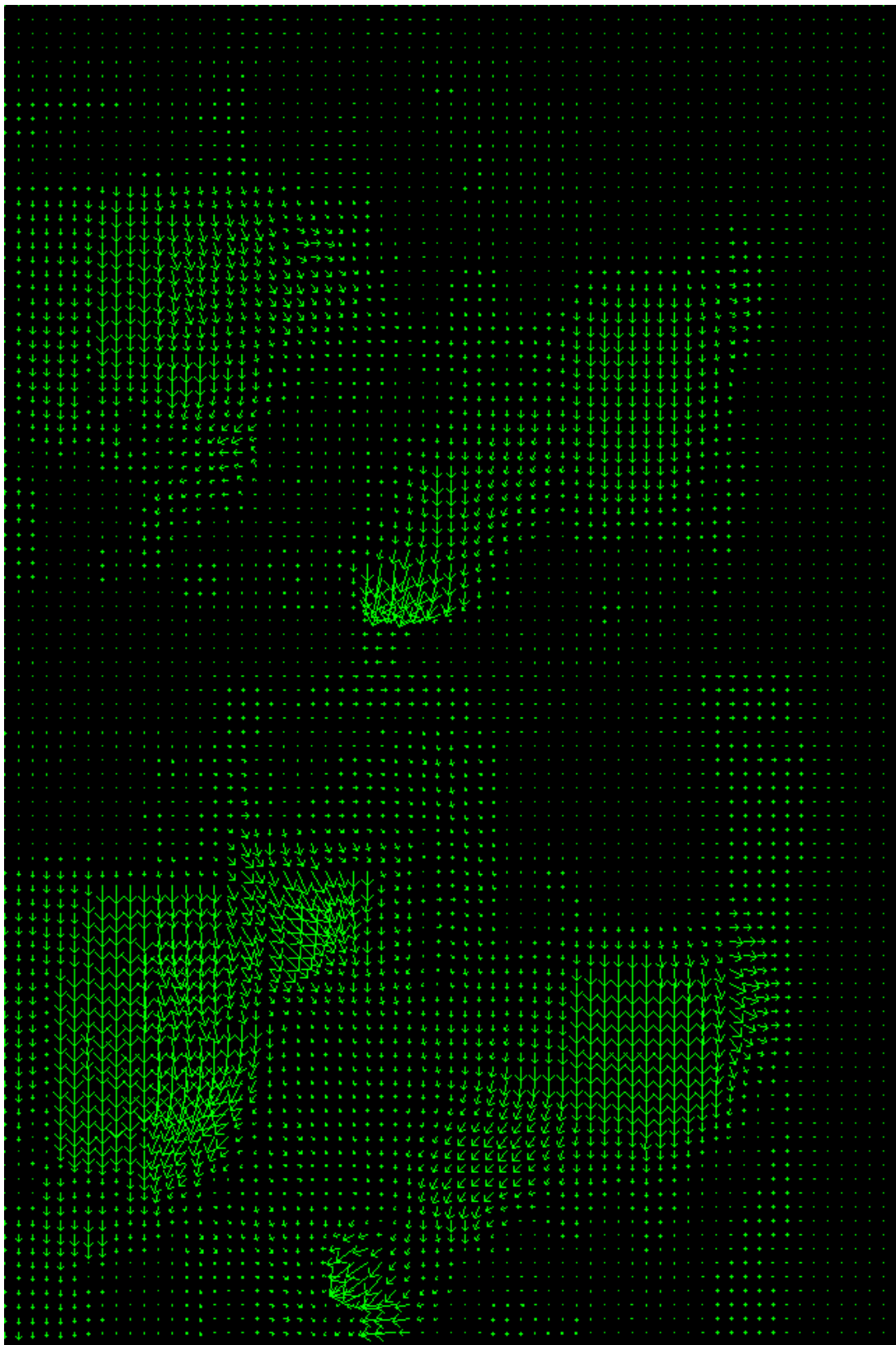


Figure 29: ps6-5-a-1 quiver plot



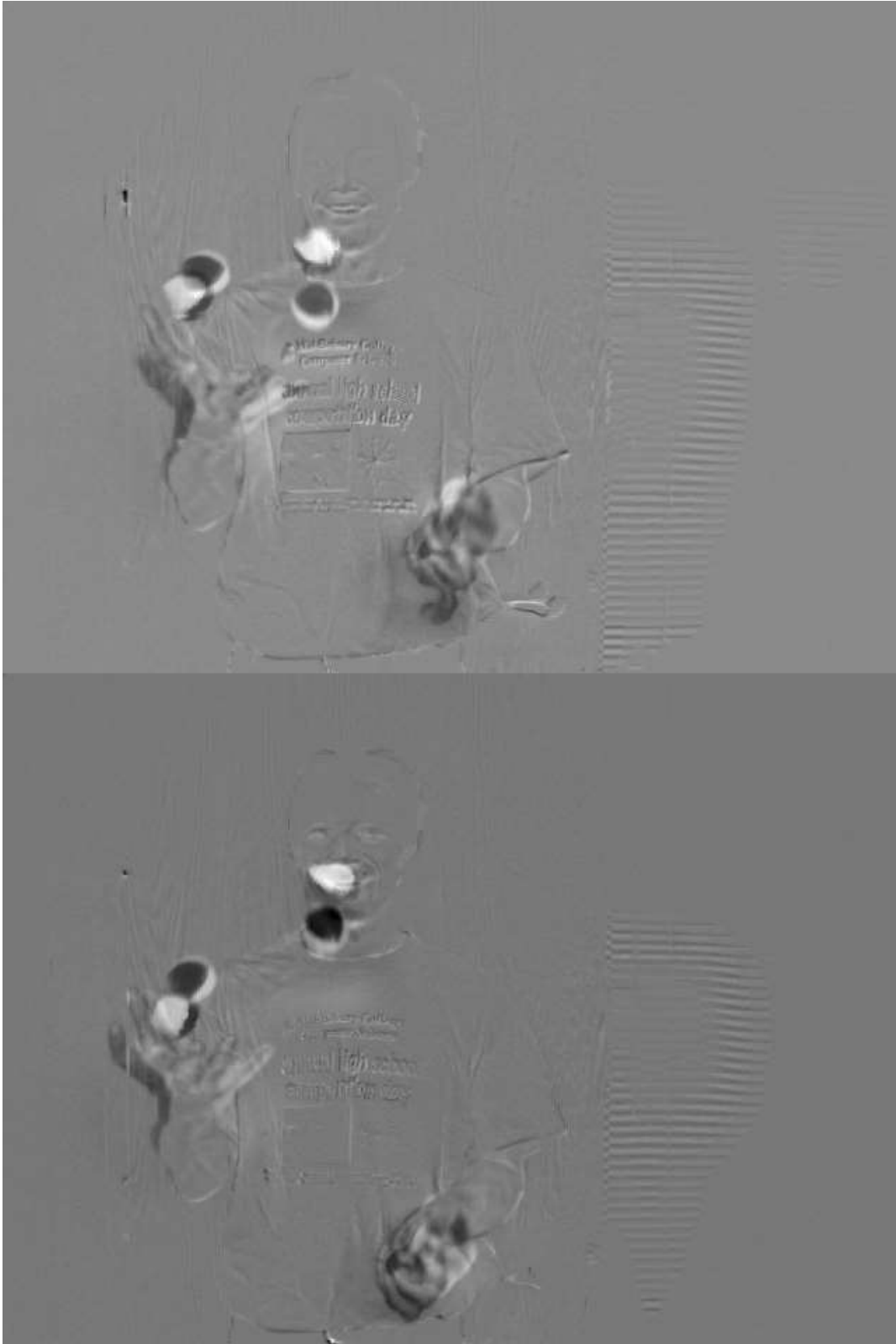


Figure 30: ps6-5-a-2.png