Exercise 1: Optical flow

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I. Introduction

In this exercise we implemented two of the most well known optical flow estimation methods, the Lucas-Kanade method and the Horn-Schunck method.

II. Experiments

Figure 1 shows the results of my implementation of the two mentioned algorithms. As we can see from the color spectrum, Horn-Schunck method performs more smoothly than Lucas-Kanade method, which is expected.

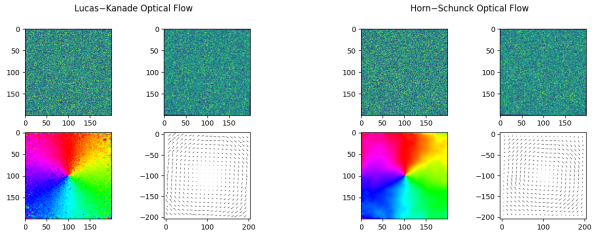

Figure 1: Optical flow on the random noise images.

Figures 2, 3 and 4 show performance of both methods on multiple scenes. As we can see, Horn-Schunck method performs much better than Lucas-Kanade method. The reason for this might be the fact that those images violate the small movement assumption, which is vital part of Lucas-Kanade method.

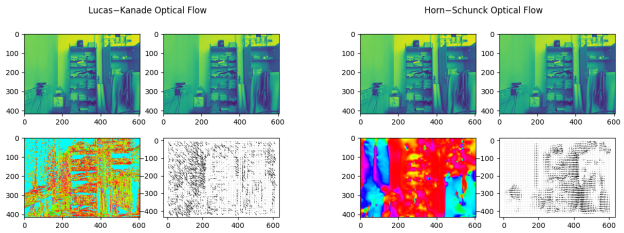

Figure 2: Optical flow on office1 images.

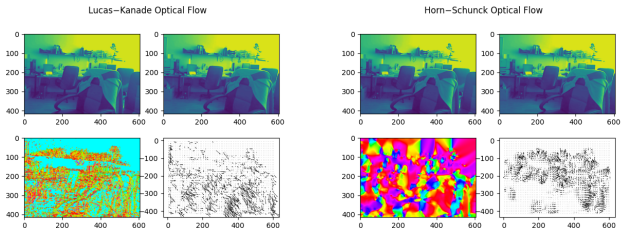

Figure 3: Optical flow on office2 images.

Lucas-Kanade optical flow cannot be estimated reliably when $D = \sum_N I_x^2 \cdot \sum_N I_y^2 - \left(\sum_N I_{xy}\right)^2 = 0$. In our case, we check whether $D = 0$ or not, in which case we could add some large number to D so when we divide with D we get some number close to zero. Another solution would be to calculate Harris response, which estimates the lowest eigenvalue. However, this worsened the results.

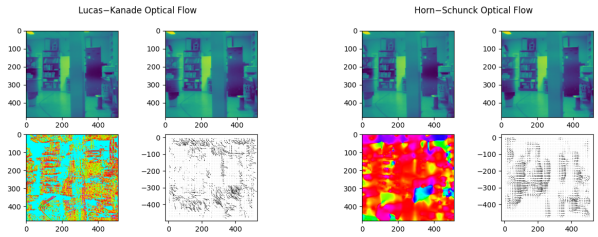

Figure 4: Optical flow on lab2 images.

In Lucas-Kanade we need to specify the size of a kernel, which determines how many neighboring pixels we consider when we calculate optical flow. Figure 5 shows the difference between kernels with sizes 3 and 9. As we can see, larger kernel smooths the optical field.

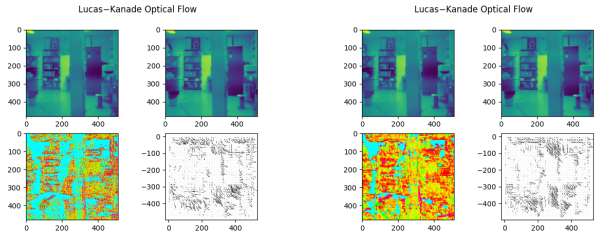

Figure 5: Difference between kernel of size 3 and 9.

In Horn-Schunck we have to specify the number of iterations. As we can observe in figure 6, it affects the smoothness of the optical field.

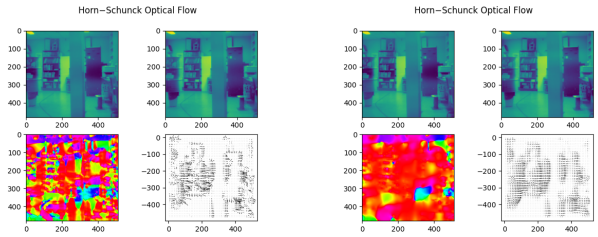

Figure 6: Difference between number of iterations (right 100, left 1000).

In real images, Lucas-Kanade takes about 0.05 seconds to calculate optical flow. On the other hand, Horn-Schunck takes up to 17.6 seconds for 1000 iterations. The difference in time is great because in second method we calculate new optical flows in each iteration of the algorithm. We could initialize vectors u and v with Lucas-Kanade method and try to lower the number of iterations. Figure 7 shows the performance of Horn-Schunck method on 100 iterations when initialize u and v like we described above. It takes approximately 1.78 seconds to calculate it. As we can observe, this method does not improve the calculation by much.

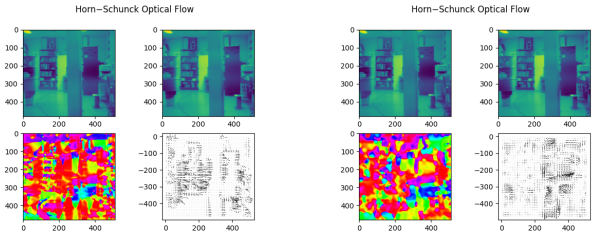

Figure 7: Difference between initialization (right normal, left with Lucas-Kanade).

III. Conclusion

In this assignment, we implemented Lucas-Kanade an Horn-Schunck method for optical flow estimation. The algorithms worked best on random noise images. However, Horn-Schunck algorithm performed much better on real world images, which can be due to wrong implementation of Lucas-Kanade method or the violation of some assumptions.