DIGITAL VIDEO: PERCEPTION AND ALGORITHMS
ASSIGNMENT-1

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Introduction:

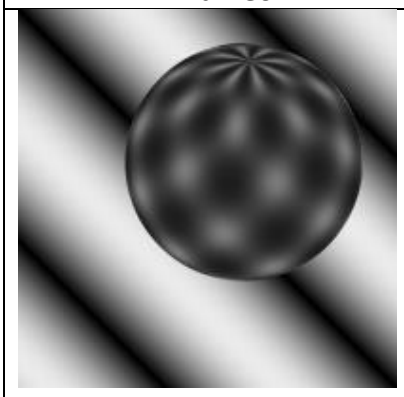
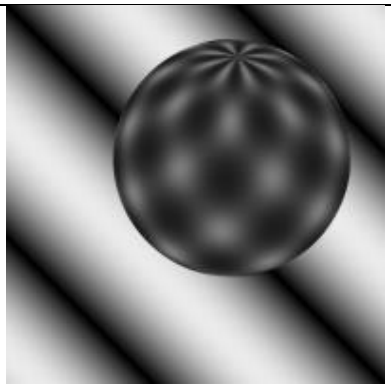
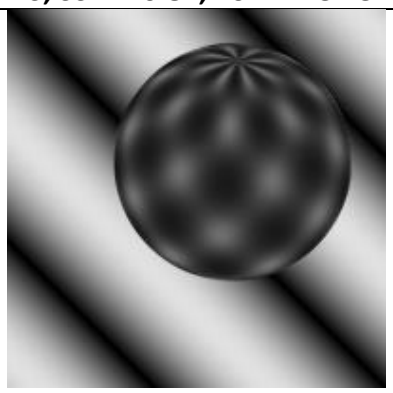
We have implemented optical flow algorithms Discrete Horn Schunk, Lukas Kanade and it's Multiscale versions with iterative optical flow algorithm. We used Middlebury paper reference for interpolation to generate intermediate frame. We tested these algorithms on corridor dataset and sphere dataset. We also calculated structural similarity index (SSIM) and Peak Signal to Noise ratio (PSNR) for all prediction. All the results are submitted along with the code in Results folder.

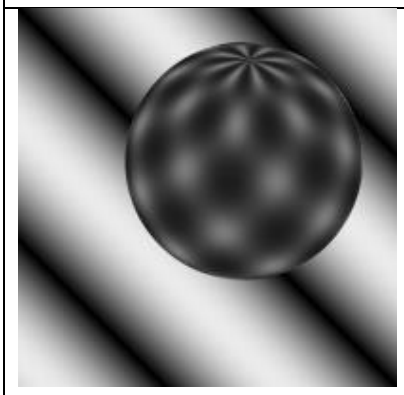
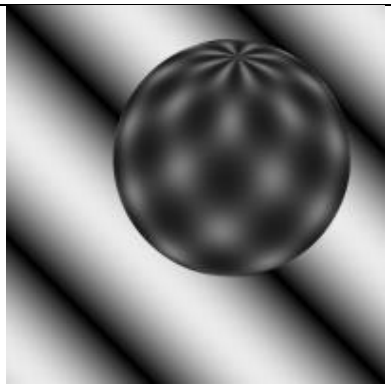
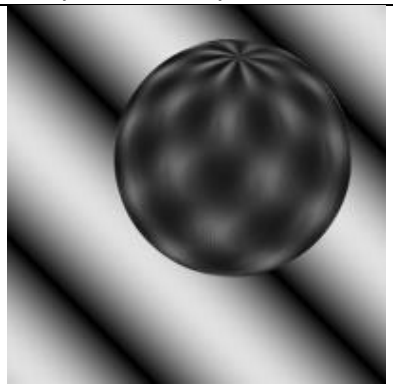
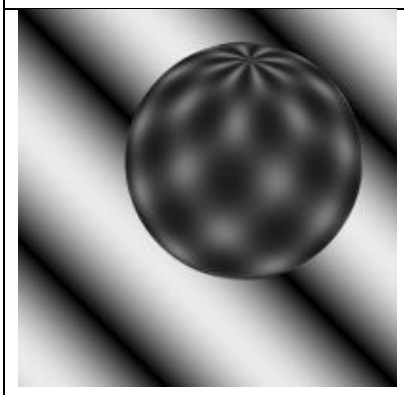
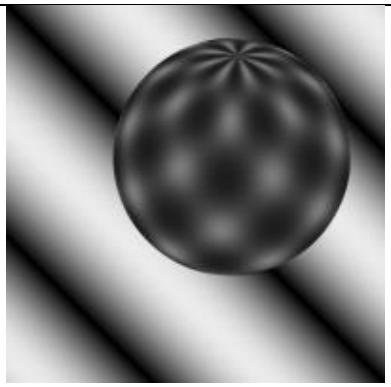
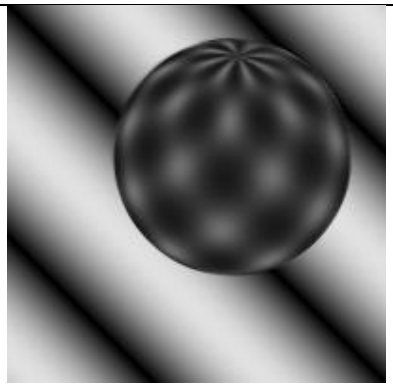
https://github.com/jkmathuriya/Video-Interpolation-Using-Different-OpticalFlow-Algorithms

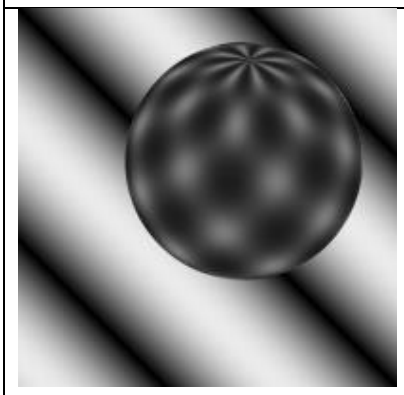
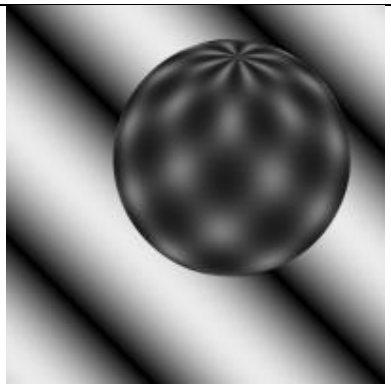
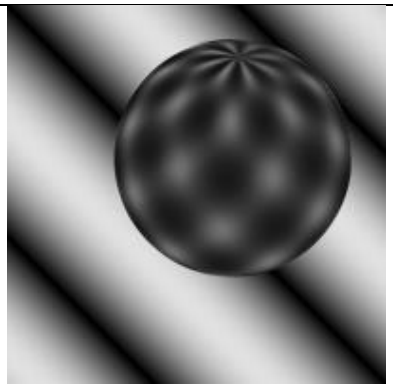
HS: Horn Schunk
LK: Lukas Kanade
MLK3: Multiscale Lukas Kanade (No. of scale 3)
MHS3: Multiscale Horn Schunk (No. of scale3)
For Lukas Kanade N=9
For Horn Schunk maximum iteration=400
Lambada = 2

Forward Flow:

We calculated optical flow between n to n+2 frame and then used optical flow to reproduce n+2 frame. Some results and scores SSIM and PSNR are listed here.

		
Frame0	**Frame2**	**HS, SSIM=0.82, PSNR=25.45**
		
Frame0	**Frame2**	**HS, SSIM=0.99, PSNR=40.76**

		
Frame0	**Frame2**	**LK, SSIM=0.74, PSNR=24.33**
		
Frame0	**Frame2**	**LK, SSIM=0.98, PSNR=36.83**
		
Frame0	**Frame2**	**MHS3,SSIM=0.72, PSNR=21.57**
		
Frame0	**Frame2**	**MHS3,SSIM=0.99, PSNR=40.03**

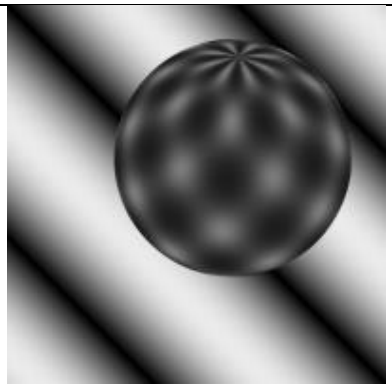
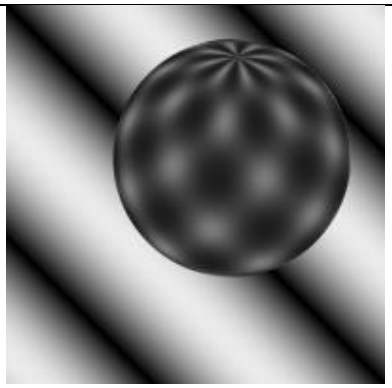
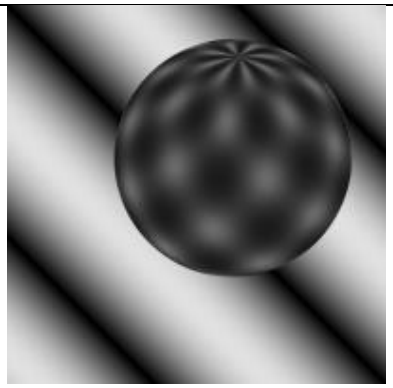
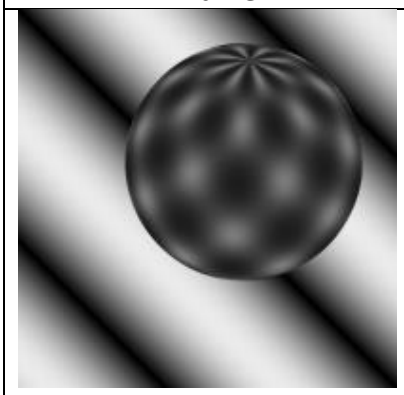
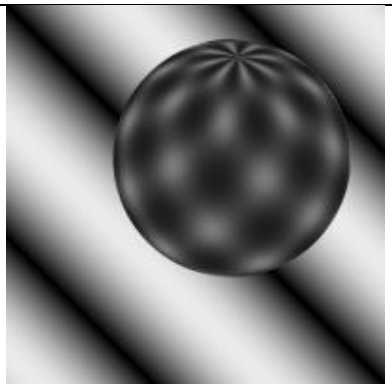
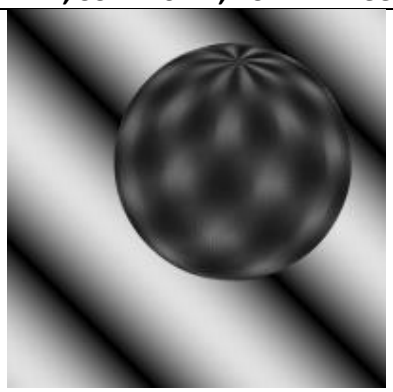
		
Frame0	**Frame2**	**MLK3 SSIM=0.82 PSNR=25.45**
		
Frame0	**Frame2**	**MLK3, SSIM=0.99, PSNR=43.34**

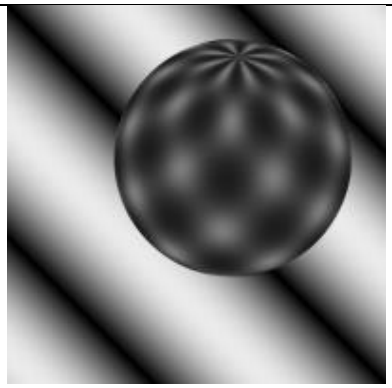
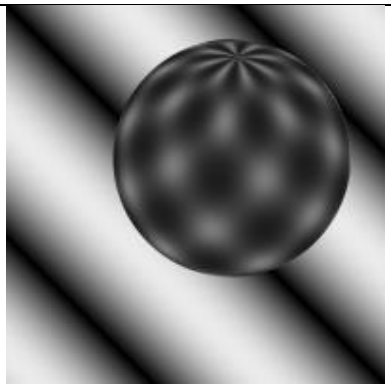
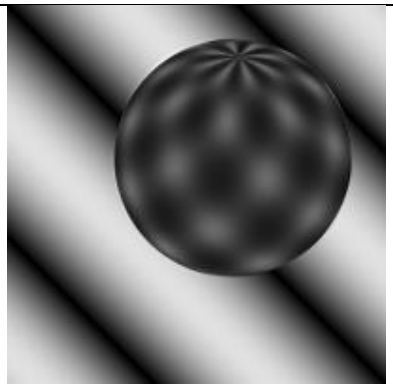
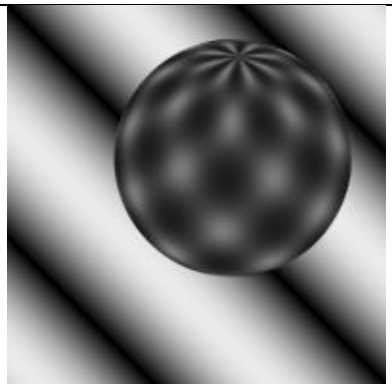
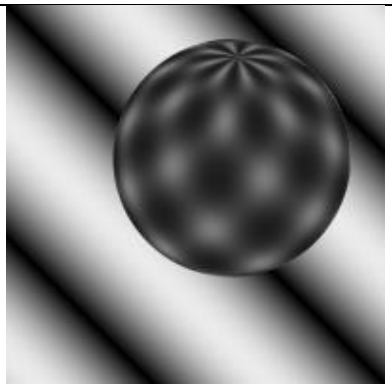
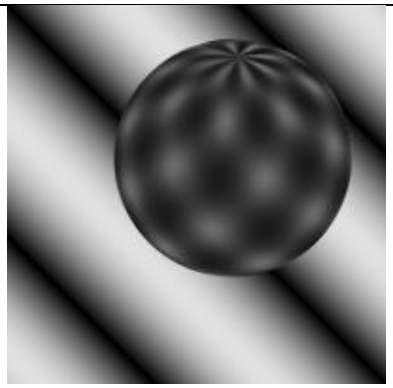
From results we can see that on the sphere dataset best prediction is given by multiscale Lukas Kanade (Local motion) and on the corridor dataset bets prediction is given by Horn Schunk (Global Motion). Multiscale version of Horn Schunk does not help to improve prediction scores but with respect to human perception it looks better.

Backward Flow:

We calculated optical flow (Backward Flow) between n+2 to n frame and then used optical flow to reproduce n frame. Some results and scores SSIM and PSNR are listed here.

		
Frame2	**Frame0**	**HS, SSIM=0.82, PSNR=25.45**

		
Frame2	**Frame0**	**HS, SSIM=0.99, PSNR=40.76**
		
Frame2	**Frame0**	**LK, SSIM=0.74, PSNR=24.33**
		
Frame2	**Frame0**	**LK, SSIM=0.98, PSNR=36.83**
		
Frame2	**Frame0**	**MHS3,SSIM=0.76, PSNR=22.42**

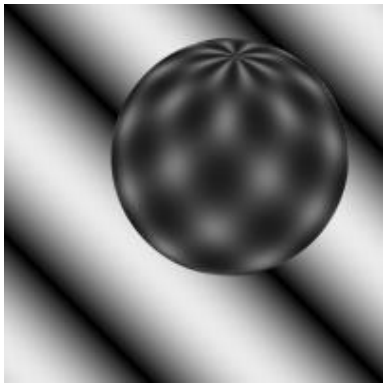
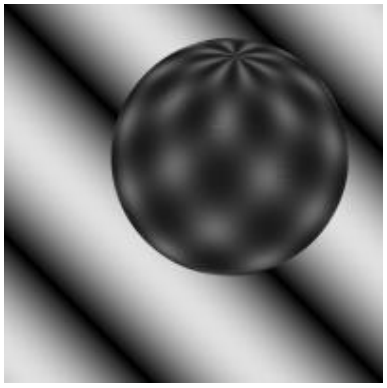
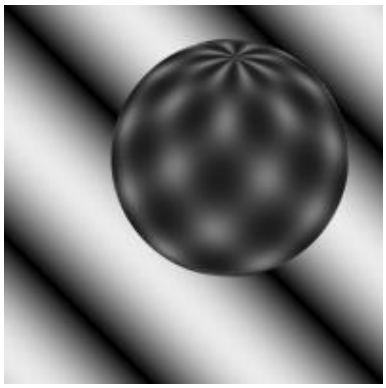
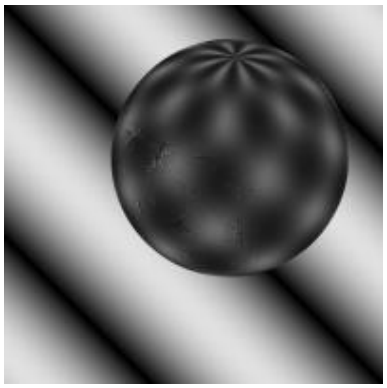
		
Frame2	**Frame0**	**MHS3, SSIM=0.99,PSNR=40.02**
		
Frame2	**Frame0**	**MLK3 SSIM=0.79 PSNR=26.01**
		
Frame2	**Frame0**	**MLK3, SSIM=0.99, PSNR=43.43**

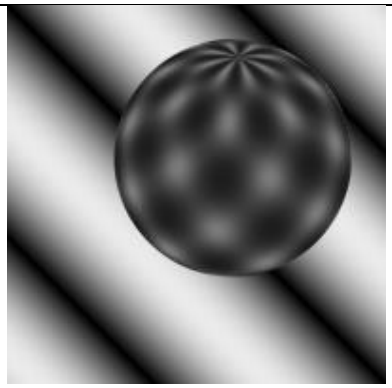
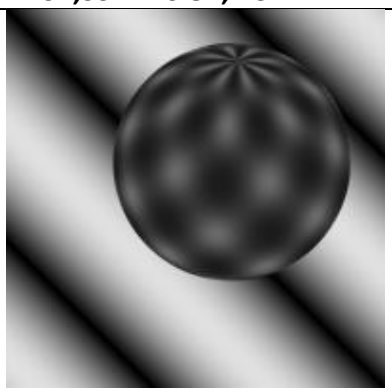
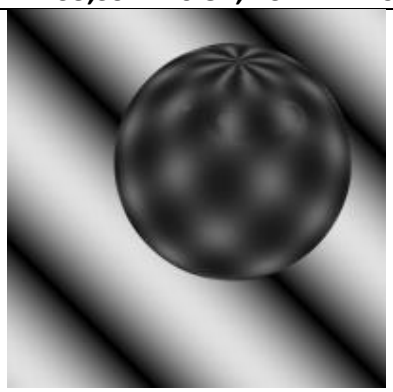
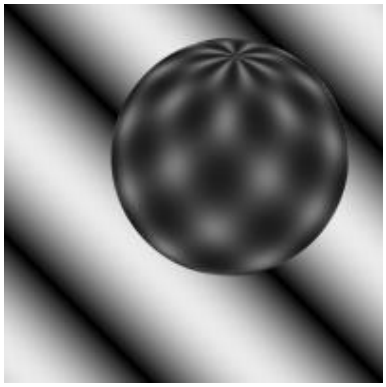
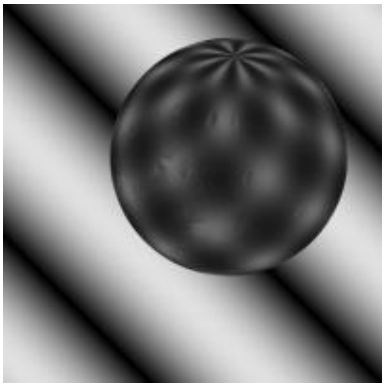
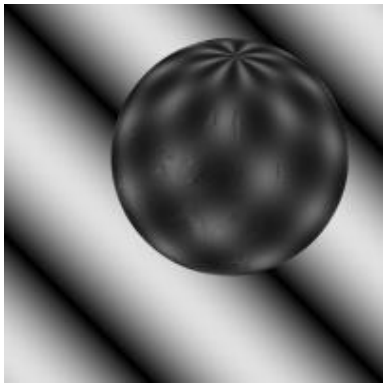
Similar results are found as were in Forward flow. Only slight variation in scores can be seen.

Interpolated Intermediate Frame:

To construct intermediate frame we used forward flow to generate a flow for temporal time 0.5. And used this flow to construct intermediate frame. We used backward flow to improve the quality of the constructed frame by detecting occlusions. Predicted frame and their ground truth are listed here.

Frame 1 is Ground Truth frame

 Frame1		 HS, SSIM=0.57, PSNR=18.44
 Frame1		 HS, SSIM=0.99, PSNR=46.91
 Frame1		 LK, SSIM=0.55, PSNR=18.27
 Frame1		 LK, SSIM=0.99, PSNR=43.77

 Frame1	 MHS4,SSIM=0.54, PSNR=17.72	 MHS3,SSIM=0.54, PSNR=17.62
 Frame1	 MHS4, SSIM=0.99,PSNR=47.44	 MHS3, SSIM=0.99,PSNR=47.87
 Frame1	 MLK4, SSIM=0.52 PSNR=17.88	 MLK3 SSIM=0.52,PSNR=17.91
 Frame1	 MLK4, SSIM=0.99, PSNR=44.73	 MLK3, SSIM=0.99, PSNR=44.99

All the intermediate frame constructed are better for sphere dataset by all variants of algorithms compare to corridor dataset. In case of corridor dataset intermediate frame is best constructed by Horn Schunk Algorithm. And for the sphere dataset the best intermediate frame is constructed by Multiscale Horn Schunk at the scale of 3, And increasing scale to 4 reduces the PSNR and SSIM scores.

Conclusion:

Question 1,2 and 3 are answered above. Used SSIM and PSNR scores to compare quality of frame. Horn Schunk algorithm time complexity is high and works better in case of global movement as per corridor dataset. For local movement Horn Schunk algorithm is also perform similar to Lukas Kanade but it is better to choose Lukas Kanade which is less time complex. In case of Multiscale variants increasing too much scale does not improve the estimation of optical flow. It increases up-to a point then starts decreasing (Scale 3 worked best for us).

To answer the question no. 4 we used the interpolate value for that pixel using first frame and second frame and fill it by the average of these two.

Note: Results for other frames and respective scores are submitted in the Result folder. Running main file will run the all method and will same the results in Results subfolders respectively.