Q1. Vehicle Motion: Velocity Proxy via Sparse Optical Flow

Method: Spatial (Ix, Iy) and temporal (It) gradients; windowed Lucas–Kanade in an ROI; eigenvalue test on A^T A for reliab

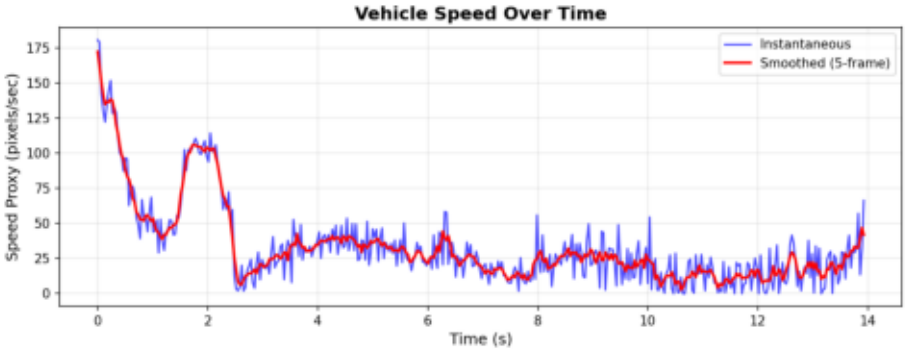
Selected ROI (first frame)

Flow overlay (low activity)

Flow overlay (medium activity)

Flow overlay (high activity)

Speed proxy over time (pixels/sec)



Observations: Median flow magnitude correlates with traffic activity; eigenvalue threshold removes weak-texture windows.

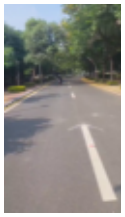
Q2. Video Retiming: One Intermediate Frame for Slow Motion

Method: Pyramidal LK forward/backward flows; halfway warps at 0.5(u,v) and 0.5(-u,-v); blended average.

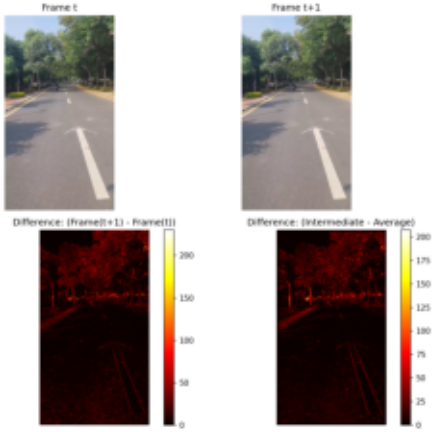
Frame It

Frame It+1

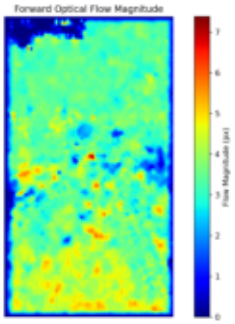
Synthesized middle



Absolute-difference heatmaps (before vs after)



Forward flow magnitude

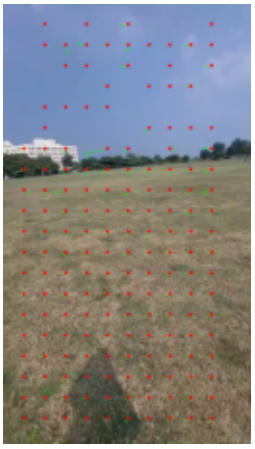


Result: 2x slow motion generated; halfway warps reduce residual error compared to naive average.

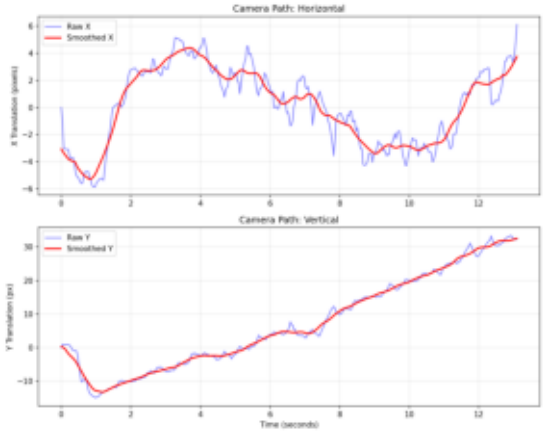
Q3. Camera Shake Removal: Basic Translation Stabilisation

Method: Sparse LK grid; per-frame translation via median; path accumulation and moving-average smoothing; inverse war

Sparse flow used for translation estimate



Raw vs smoothed camera path (X/Y)

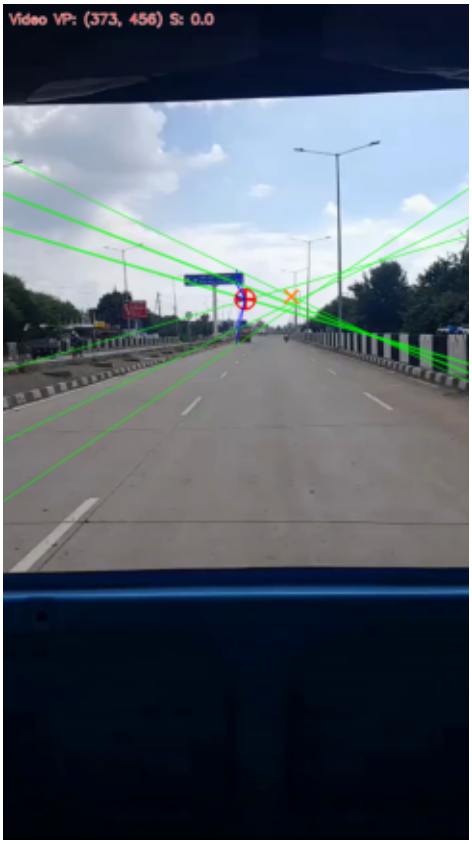


Result: Side-by-side stabilized video shows reduced jitter; smoothed path removes high-frequency shake.

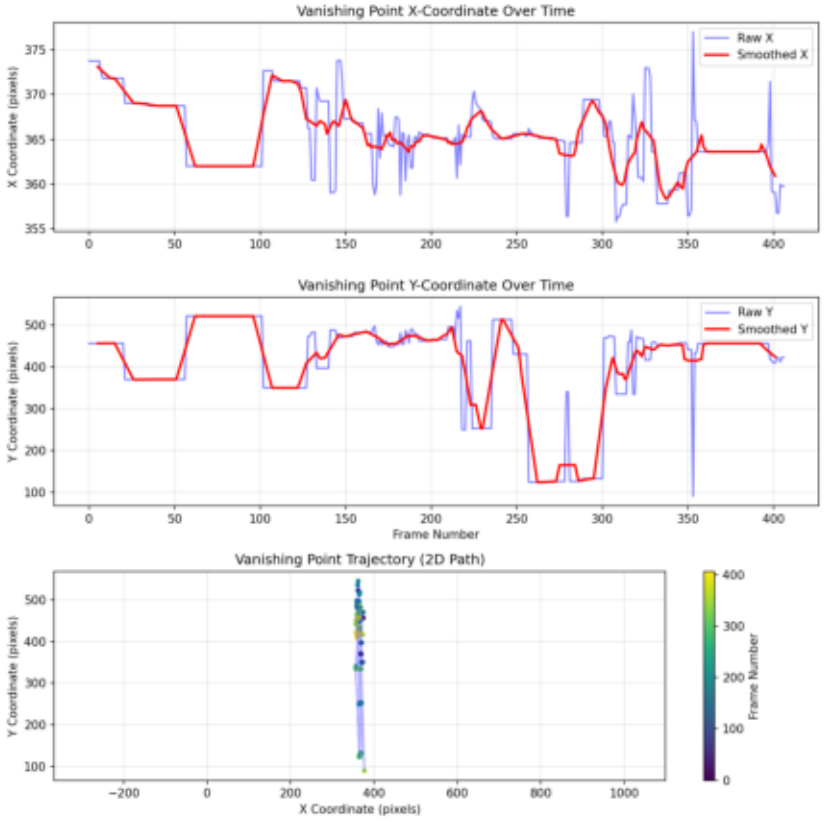
Q4 (Bonus). Real-Time Vanishing Point Estimation in Video

Method: Manual Canny edges + Hough lines; angle filtering; pairwise intersections with center/height weighting; temporal

Detected lines and Vanishing Point overlay (sample frame)



Vanishing point coordinates over time and 2D trajectory



Observation: VP remains centered horizontally and upper in the frame across the clip, consistent with road perspective.