STEADIFACE: REAL-TIME FACE-CENTRIC STABILIZATION ON MOBILE PHONES

Fuhao Shi Sung-Fang Tsai Youyou Wang Chia-Kai Liang

Google

INTRODUCTION

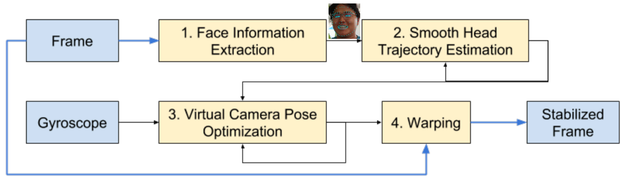
- Face is the main focus in selfie videos, live show or vlogging.
- Traditional EIS only stabilizes background, and leaves face unstabilized.
- Steadiface simultaneously stabilizes both the face motion and background.
- Steadiface is the first real-time, what you see is what you get front camera stabilization solution on mobile devices.

Face trajectory comparison between input (left), fused EIS (background only, middle), and Steaiface (right). Each frame is the average of consecutive 15 frames.

CHALLENGES

- Face motion is complex (pose and expressions) with many corner cases (illumination, occlusions, entering/leaving scene, etc.).
- Face and background smoothness need to be combined and balanced.
- Tight time/power budget: realtime on mobile devices.

SOLUTION



FACE-GYRO COMBINED STABILIZATION

- 2D facial landmarks and 3D head pose are extracted from the input video frame.
- Smooth 2D face center is then estimated from the 2D facial landmarks.
- Camera rotation is calculated from the gyro data.
- A virtual camera pose is then optimized so that the stabilized face is located at the estimated face center, and virtual camera rotation changes smoothly.

OPTIMIZATION WITH A UNIFIED FACE-BACKGROUND STABILITY METRIC

- Face stability is measured a the deviation of stabilized face center from the target head center, and background stability is measured by how smooth the virtual camera pose changes across frames.
- The two metrics (and some other terms) are combined into one single objective function, and solved by nonlinear optimization.

$$\begin{aligned}&\text{argmin}_{\mathcal{P}_v} w_f E_f(\mathcal{P}_v) + w_d E_d(\mathbf{r}_v) + w_o E_o(\mathbf{r}_v) + \\ &w_r E_r(\mathbf{r}_v) + w_t E_t(\mathbf{t}) + w_p E_p(\mathcal{P}_v).\end{aligned}$$

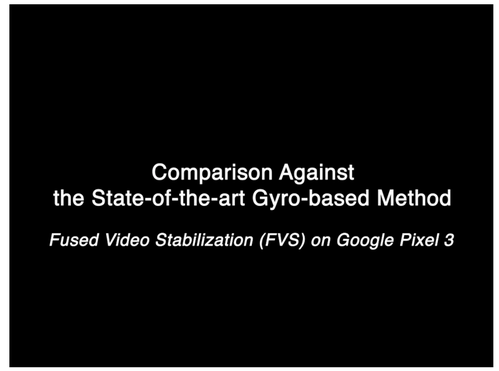
DYNAMIC OPTIMIZATION TERM WEIGHT ADJUSTMENTS

The weights of each term are dynamically adjusted based on the 3D head pose, gyro motion and landmark confidence so that

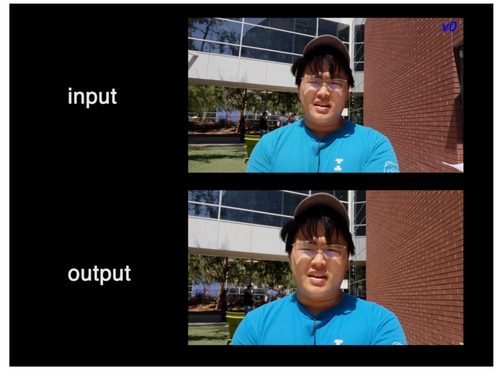
- Virtual camera does not move when head is purely rotating or the camera is stable (e.g. on a tripod).
- Virtual camera does not jump around when landmarks are inaccurate due to random occlusions or extreme head poses.

COMPARISONS WITH THE STATE-OF-THE-ART

- V.s. gyro-based fused video stabilization on Google Pixel 3.
- V.s. Selfie video stabilization by *Yu* and *Ramamoorthi.*



RESULTS



CONCLUSION

- A novel face-centric stabilization method that stabilizes both head and camera motion.
- Face (foreground) and background stability are formulated into a single unified objective function.
- Very efficient on a modern mobile phone (8.1 ms/frame).