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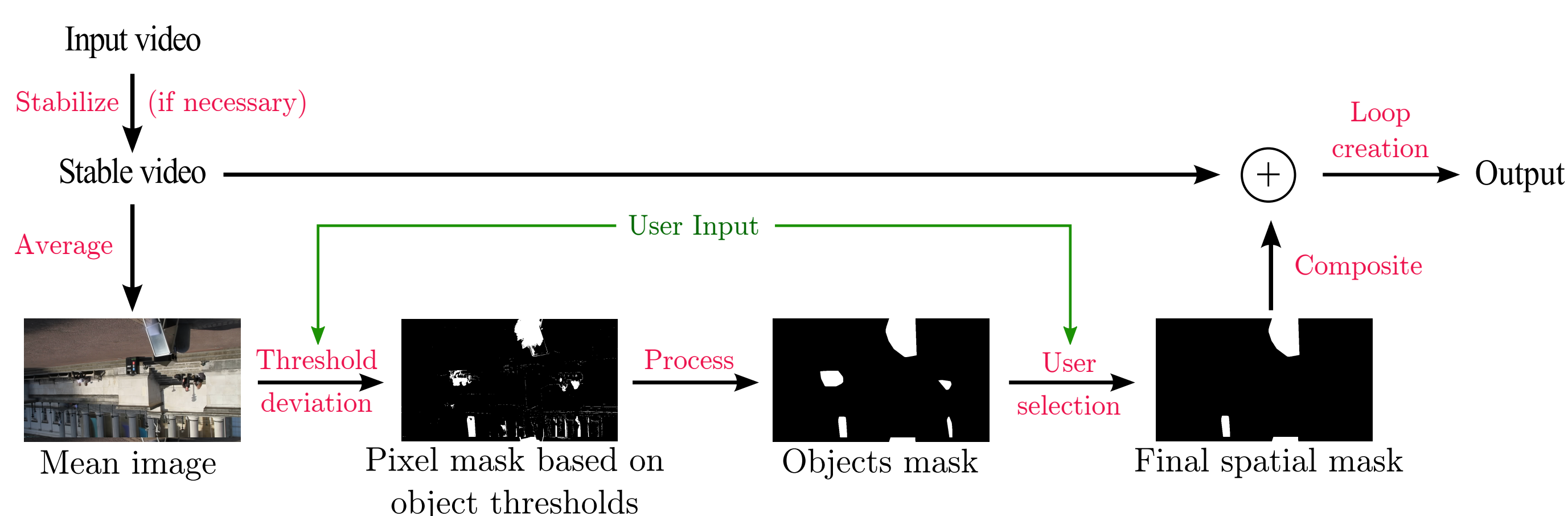
## Cinemagraphs

**Problem:** How to capturing the dynamics of a moment?

- A photograph can only draw attention to one specific instant, not the dynamics of a moment;
- A video can capture the dynamics, but it is difficult to focus on one short specific moment.

**Solution:** *Cinemagraphs* – short, seamlessly looping videos, where only parts of the scene are animated to emphasize select dynamics in the scene.

## Algorithm Overview



## Video Stabilization

Shaky camera motions ruin the *cinemagraph* effect. Existing algorithms (e.g., Deshaker and Adobe After Effects Warp Stabilizer) do not remove all motion in the background of a hand-held video clip (Figure 1).

We propose a warping-based technique:

1. Find KLT feature tracks through our video volume;
2. Reject tracks with RANSAC that suffer large reprojection errors;
3. Locally warp the volume on a frame-by-frame basis using as-affine-as-possible moving least squares [1].

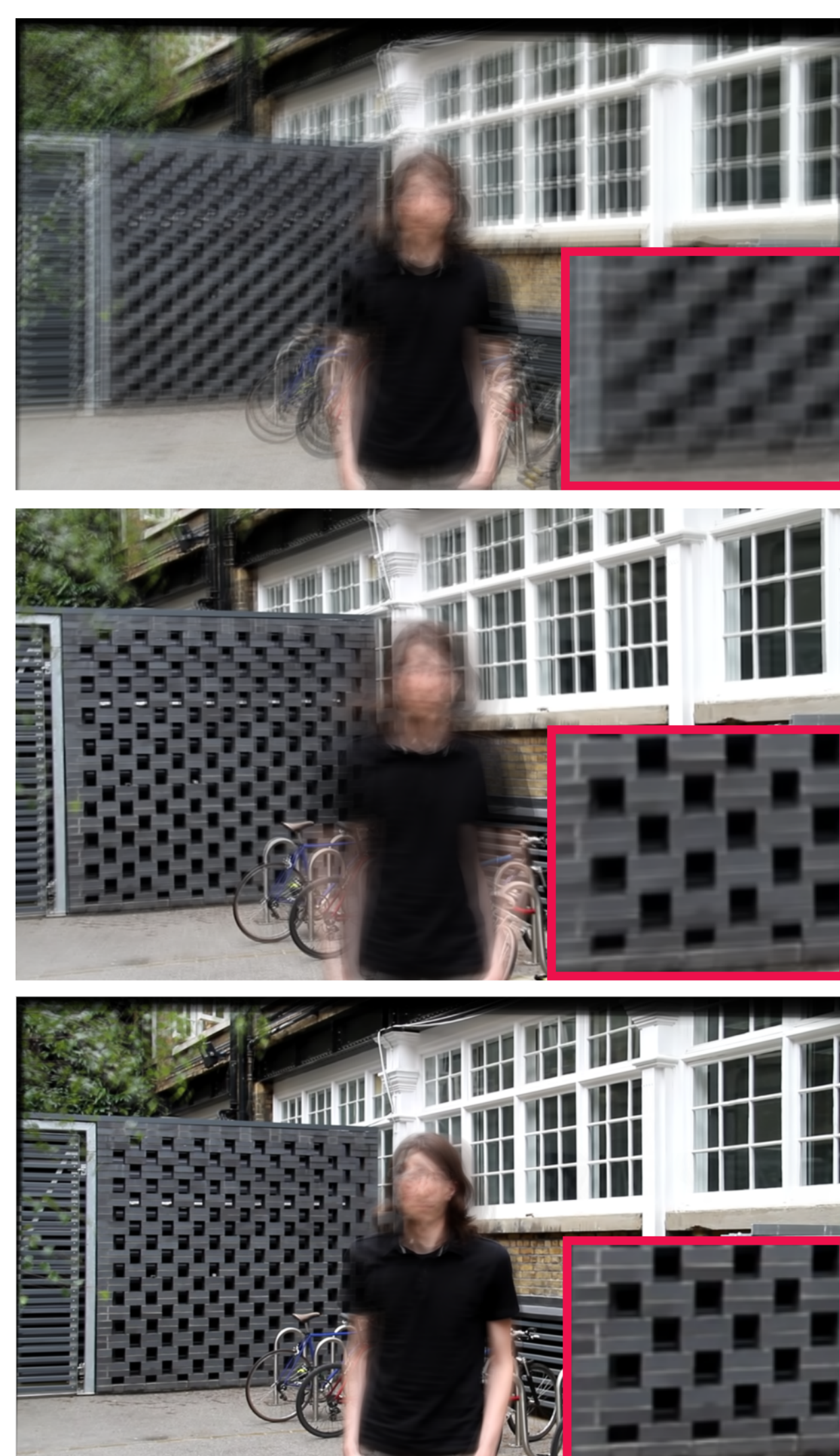


Figure 1: **Stabilization results.** *Top:* Deshaker. *Middle:* Adobe After Effects Warp stabilizer. *Bottom:* Our method.

## Motion Segmentation

We adopt different segmentation strategies depending on the application type:

- Time-critical applications (for mobile device): Chebychev distance quickly provides a good motion mask;
- Less constrained applications: structural similarity [2] for a better motion mask.

## User Input

The user is shown automatically-calculated motion regions from the input video:

- Scrolling the mouse wheel makes simple threshold changes for fine adjustments to the binary mask;
- The user can paint the mask to include or exclude motions for artistic effect;
- The user is free to browse the video volume to see the effect of the current mask on the output.

Once happy with the motion regions:

- Left clicking a highlighted region marks it as a keyframe within a looping region;
- Right clicking a region freezes it for the duration of the cinemagraph.

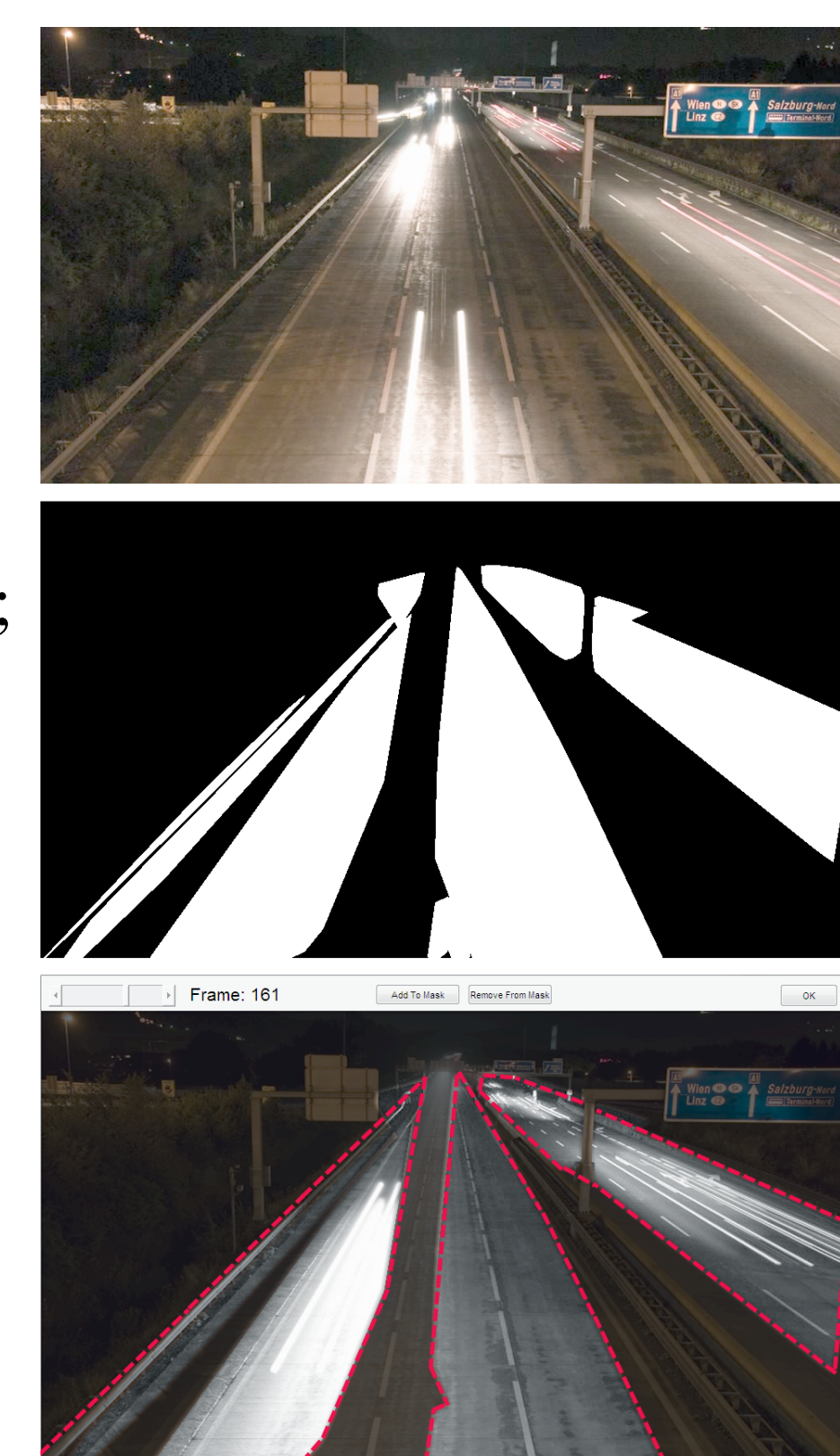


Figure 2: **Bottom:** Motion regions are desaturated until the user selects them for inclusion.

## Loop Generation

For each chosen motion region:

- We compute the sum of squared difference (SSD) matrix [3];
- The user-specified keyframe is a loop search starting point within the matrix;
- Iterative search over loop length and SSD thresholds generates candidate loops containing the keyframe;
- Given an output length, we schedule best-matching loops for each motion region.

We interpolate new frames at the end of loops to smoothly match temporal boundaries.

## Conclusion

We present a system to assist in the authoring of cinemagraphs from unstable input video. Our system can run automatically, only requiring the user to select desired output motion regions. User mask painting and looping and freezing of regions provides creative tools for the creation of cinemagraph.

You can find more input, output and supplementary videos by pointing your smartphone at the QR code.



## References

- [1] Scott Schaefer, Travis McPhail, and Joe Warren. Image deformation using moving least squares. *ACM Trans. Graph.*
- [2] Zhou Wang, A.C. Bovik, H.R. Sheikh, and E.P. Simoncelli. Image quality assessment: from error visibility to structural similarity. *Image Processing, IEEE Transactions on.*
- [3] A. Schödl, R. Szeliski, D. H. Salesin and I. Essa. Video textures. In *Proceedings of the 27th annual conference on Computer graphics and interactive techniques*