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**CS 445 - Project 5: Image Based Lighting**

Complete the claimed points and sections below.

**Total Points Claimed** **[ ] / 250**

**Core**

| | | |
|---|---|---|
| 1. | Stitch two key frames | [ ] / 20 |
| 2. | Panorama using five key frames | [ ] / 15 |
| 3. | Map the video to the reference plane | [ ] / 15 |
| 4. | Create background panorama | [ ] / 15 |
| 5. | Create background movie | [ ] / 10 |
| 6. | Create foreground movie | [ ] / 15 |
| 7. | Quality of results and report | [ ] / 10 |

**B&W**

| | | |
|---|---|---|
| 8. | Insert unexpected object | [ ] / 15 |
| 9. | Process your own video | [ ] / 20 |
| 10. | Smooth blending | [ ] / 30 |
| 11. | Improved fg/bg videos | [ ] / 40 |
| 12. | Generate a wide video | [ ] / 10 |
| 13. | Remove camera shake | [ ] / 20 |
| 14. | Make streets more crowded | [ ] / 15 |

### 1. Stitch two key frames

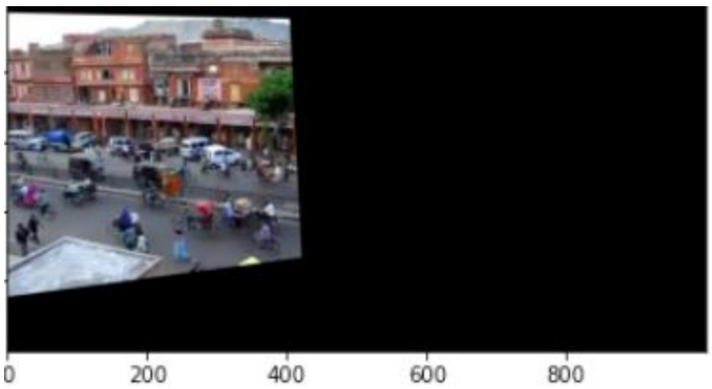
Include

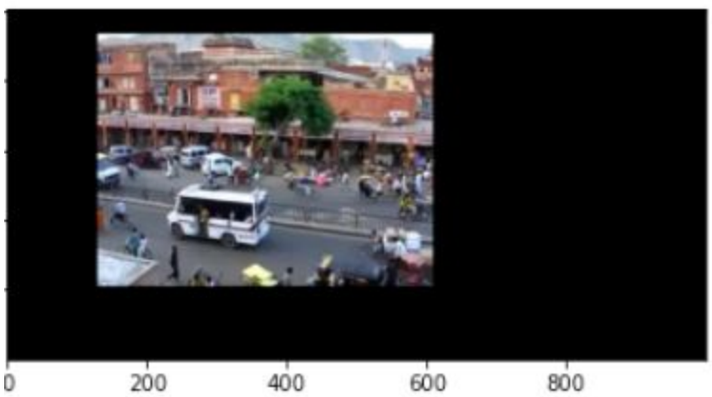
- Display of image frames 270 and 450 with the red plot lines showing corresponding regions


- Printout of 3x3 homography matrix normalized so that the largest value is 1

```
[[ 1.0000000e+00  4.8260450e-02 -2.0551419e+02]
 [ 1.5332730e-02  9.4369072e-01 -1.6304251e+01]
 [ 4.0216465e-04  1.6125945e-06  8.0542314e-01]]
```

Result:




**2. Panorama using five key frames**

Include your panoramic image

**3. Map the video to the reference plane**

Include:

- Link to your video
  **https://youtu.be/4yTrNC8TB1k**

- Display frame 200 of your video

- Briefly explain how you solved for the transformation between each frame and the reference frame
  **In part 2, we calculated H for the key frames from [90, 270, 450, 630, 810]. Thus, in part 3, I used np.argmin to determine which key frame fits current frame the best, and make use of that keyframe's H.**

**4. Create the background panorama**

Include:

- Picture of the background panorama

- Explain your method of computing the background color of a pixel
  **I used np.median to take the median of the pixel values. However, the cars frequently pass through some places in the picture, and thus the background pixel exposures relatively less time, which results the blur in the picture.**

**5. Create the background movie**

Include:

- Link to your video
- Display frame 200 of your video

**6. Create the foreground movie**

Include:

- Link to your video
- Display frame 200 of your video

**7. Quality of results / report**

Nothing extra to include (scoring: 0=poor 5=average 10=great).

**8. Insert unexpected object**

Include link to your video.

**9. Process your own video**

Include:

- Background image
- Link to background video
- Link to foreground video

**10. Smooth blending**

Include panoramic image from part 2 with better blending

**11. Smooth blending**

Include panoramic image from part 2 with better blending

**12. Generate a wide video**

Include link to your video

**13. Remove camera shake**

Include link to your stabilized video

**14. Make street more crowded**

Include link to your video

**Acknowledgments / Attribution**

List any sources for code or images from outside sources