HW3

Submit Assignment

Due Mar 8 by 12pm **Points** 100 **Submitting** a file upload

This homework is about stereo geometry. For this assignment, you will use the following five stereo pairs of images: Stereo_images.zip. **For each stereo pair** of images, perform the following tasks:

- **Manually** select $n^{(0)} = 10$ points $\mathbf{p}_i = [x_i, y_i, 1]^\top,\ i = 1, \ldots, n^{(0)}$, in image 1 and their corresponding points $\mathbf{q}_{i'} = [x_{i'}, y_{i'}, 1]^\top, i' = 1, \ldots, n^{(0)}$, in image 2, as precisely as possible, and record their coordinates: $C^{(0)} = \{(\mathbf{p}_i, \mathbf{q}_{i'}) :\ \ i = 1, \ldots, n^{(0)},\ \ i' = 1, \ldots, n^{(0)}\}$. Estimate the fundamental matrix $F^{(0)}$ based on $C^{(0)}$.
- Detect 100 strongest interest points in each image, then, compute their deep features, and finally match them one-to-one. You may use your code for HW1 and HW2, or any other interest point detector and deep neural network of your choice. Let these points be located in image 1at coordinates $\mathbf{p}_i = [x_i, y_i, 1]^\top, i = 1, \ldots, 100$, and in image 2 at coordinates $\mathbf{q}_{i'} = [x_{i'}, y_{i'}, 1]^\top, i' = 1, \ldots, 100$. Then, their deep-feature distances can be computed as $d_{ii'} = \|\mathbf{f}(\mathbf{p}_i) - \mathbf{f}(\mathbf{q}_{i'})\|_2$, and directly used in the Hungarian algorithm to obtain the one-to-one matching:
  $C = \{(\mathbf{p}_i, \mathbf{q}_{i'}) :\ \ i = 1, \ldots, 100,\ \ i' = 1, \ldots, 100\}$.
- From your matching solution C, **automatically** select $n^{(1)} = 30$ pairs $(\mathbf{p}_i, \mathbf{q}_{i'})$ for which the fundamental equation closely holds:

  $$C^{(1)} = \{(\mathbf{p}_i, \mathbf{q}_{i'}) : (\mathbf{p}_i, \mathbf{q}_{i'}) \in C,\ \ \text{and}\ \ \mathbf{q}_{i'}^\top\ F^{(0)}\ \mathbf{p}_i < \epsilon \approx 0\}$$

  where $F^{(0)}$ is the fundamental matrix that you estimated using the $n^{(0)} = 10$ manually selected pairs of points. Set the value of ϵ so that $n^{(1)} = 30$.
- Add the manually selected pairs of points $C^{(0)}$ to $C^{(1)}$, and thus obtain the augmented set $C^{(1)} \leftarrow C^{(1)} \cup C^{(0)}$ of $n^{(1)} = 40$ point pairs. Re-estimate the fundamental matrix $F^{(1)}$ based on the augmented $C^{(1)}$.

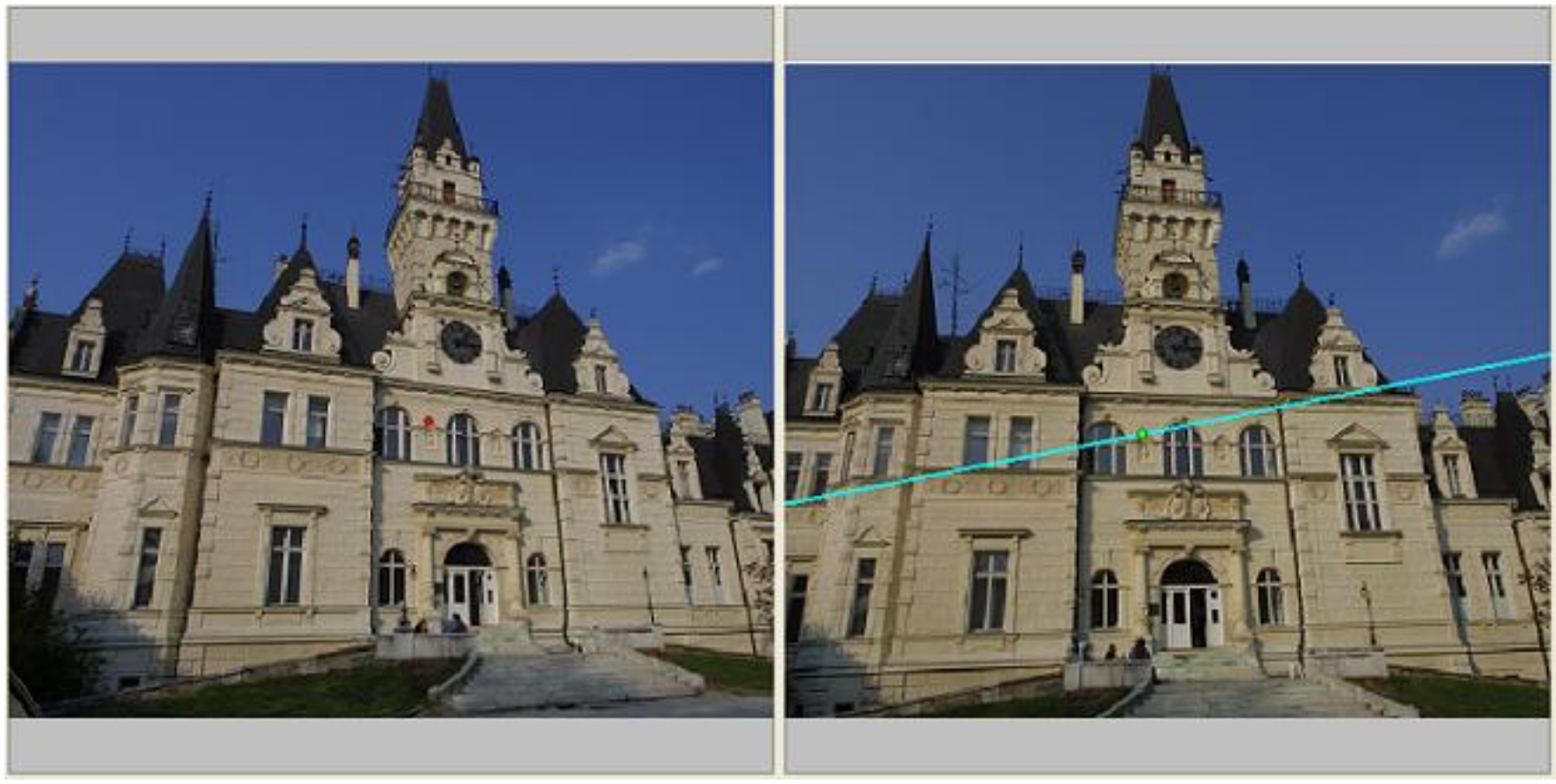
Turn in a PDF report with the following information:

1. (5 x 5 points) Five fundamental matrices $F^{(0)}$ for every stereo image pair;
2. (5 x 5 points) Five fundamental matrices $F^{(1)}$ for every stereo image pair;
3. (5 x 6 points) Five figures of the stereo image pairs depicting the following:
   1. (2 points) Clearly mark one example point selected in image 1, and the two corresponding epipolar

lines in image 2 of the point selected in image 1 -- one for $F^{(0)}$, and the other for $F^{(1)}$ (use different colors for depicting the two epipolar lines), as illustrated in the figure below.

2. (2 points) Also, in the same figure, clearly mark another example point selected in image 2, and the two corresponding epipolar lines in image 1 of the point selected in image 2 -- one for $F^{(0)}$, and the other for $F^{(1)}$.

3. (2 points) In the caption specify: the row and column of the point you selected in image 1, the row and column of the point you selected in image 2, and parameters of their four corresponding epipolar lines for $F^{(0)}$ and $F^{(1)}$. Also in the caption, comment if the epipolar lines (closely) pass through the right points.



4. (5 x 4 points) Five figures of the stereo image pairs with clearly marked epipoles in image 1 and image 2 for $F^{(0)}$ and $F^{(1)}$. In the caption, specify coordinates of the four epipoles.