Homework Image Analysis and Computer Vision

Sofisti Giorgio (10500171)

giorgio.sofisti@mail.polimi.it

Politecnico di Milano

A.Y. 2019/2020

January 27, 2020

**Contents**

1. **Iintroduction**
2. **Features Extraction**
3. **Shape Reconstruction**
4. **Metric Reconstruction**
5. **Camera Calibration**
6. **Vertical façade Reconstruction**
7. **Camera Localization**
8. **Analitical Details**
9. **Computed Results**
10. **References**

**1 Introduction**

Images provided for this homework are taken inside Sciarra palace’s internal courtyard situated in Trevi neighborhood, Rome. The palace built between 1885 and 1888 is a great representation of Liberty architecture with complex, flower inspired, decoration over all the facades. The inside courtyard is covered by a glass roof that let the sunlight penetrate inside this connecting area between two streets. The two images provided shows one internal façade from the bottom of the court. Since the images are taken during a sunny day (probably around noon) there is a high contrast between areas illuminated by sunlight, that penetrates through the glass roof, and the areas that are in the dark, a point to consider during edge detection. Another point that introduce complexity for features detection are for sure the complex decorations that are present on the facades.

Last but not least we have to consider the assumption given in the homework description about metric dimension of windows (fundamental for metric reconstruction step), orthogonality of adjacent façades and skew symmetry assumption (but not natural camera assumption) fundamental when we need to look for K calibration matrix.

**2 Features Extraction**

In order to extract relevant features form the image we have to perform a series of steps:

1. In features extraction colors are useless information to carry on that complicates and worsen the performance so we can apply rgb2gray(image) to transform the image form RGB to Gray Scale.
2. As mentioned in the introduction, since the image presents areas with different exposition we need to perform a pre-processing phase to improve accuracy and obtain better result in next phases. To do that we tested different normalization algorithms and evaluated that MATLAB function adapthisteq(image)applied twice on the image returns the best result.
3. Now we’re ready to apply to the image edge extraction algorithm. After some testing of different option (sobel, log, roberts, canny) we opted for Canny method that is the most accurate. Canny is accurate but the threshold imposed is the result of many trial and error and is fundamental for good performance of the next step.
4. Now we are ready to use the learned method of Hough transform to extrapolate from canny image relevant edges. After some parameter tuning the result in the picture below.

**3 Shape reconstruction**

Now that we have obtained some relevant image features we are ready for image reconstruction. The process involves the application of two subsequent transformation one after the other that maps the original image to the affine one ad finally to the Euclidean.

**3.0 Vanishing Points and Lines**

After the selection of relevant features for each direction (x, y, z) I’ve computed the vanishing lines and found three best approximation of vanishing points as weighted average of the vanishing points given by the intersection of vanishing lines in the respective directions. An important factor to be consider to obtain reliable and good results is to choose as many features as possible for each direction (at least 3-4 edges, definitely 2 are not enough) so that the approximation is more accurate. Below is shown the result obtained during the computation.

**3.1 Affine reconstruction**

An affine transformation is a non-singular linear transformation followed by a translation. Since an affine transformation includes non-isotropic scaling, the similarity invariants of length ratios and angles between lines are not preserved under affinity. Affinity invariance instead are parallelism between lines, the length ratio between parallel segments and the consequent ratio between areas.

In order to identify the correct transformation matrix for the affinity I’ve found the line at the infinity passing through two of the three found vanishing points found at the previous step. [pagg.49 book)

Second step pagg 54 book