

# Panorama reconstruction

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**Abstract.** The goal of Practical work is to reconstruct a panorama from two images. Given two images of the same scene but different views, the user is asked to select matching points from both images. The program then calculate the homography between the images, and then construct a panorama.

## 1. Homography computation

Given the matching points  $(x_i, y_i)$  and  $(x'_i, y'_i)$ , to wrap the coordinates of the first image to the second image we need to apply a geometric transformation defined by the homography matrix  $H$ . We can express this as the following:

$$\begin{bmatrix} x'_i \\ x'_i \\ 1 \end{bmatrix} \equiv \begin{bmatrix} h_{11} & h_{12} & h_{13} \\ h_{21} & h_{22} & h_{23} \\ h_{31} & h_{32} & h_{33} \end{bmatrix} \begin{bmatrix} x_i \\ y_i \\ 1 \end{bmatrix}$$

where  $h_{ij}$  are the homography  $H$  values.  $h_{33}$  is set to 1. Thus, to compute the homography we solve the following linear system:

$$\begin{bmatrix} & & & & & \vdots & & \\ x_i & y_i & 1 & 0 & 0 & 0 & -x'_i x_i & -x'_i y_i \\ 0 & 0 & 0 & x_i & y_i & 1 & -y'_i x_i & -y'_i y_i \\ & & & & & \vdots & & \end{bmatrix} \begin{bmatrix} h_{11} \\ h_{12} \\ h_{13} \\ h_{21} \\ h_{22} \\ h_{23} \\ h_{31} \\ h_{32} \end{bmatrix} = \begin{bmatrix} \vdots \\ x'_i \\ y'_i \\ \vdots \end{bmatrix}$$

## 2. Panorama construction

We want to wrap image  $I_2$  with image  $I_1$ . We compute the forward homography mapping of  $I_1$ 's bounds, to get the bounding box for the panorama  $I$ , that fits both  $I_2$  and  $I_1$  transformed bounds.

Now, we loop over each pixel in  $I$ . We compute the inverse homography mapping to find the corresponding points in  $I_1$  and  $I_2$ . If the corresponding point is within the bounds of  $I_1$  (or  $I_2$ ), we take the bilinear interpolation from  $I_1$  (or  $I_2$  resp.). However, when the corresponding point is in the overlap area we take the average of colors from both images.

## 3. Results

### 3.1. 4 points

Using only 4 matching points allows a good construction of the panorama. However, an apparent vertical contrast lines and blurring, can be noticed on the overlapping area.

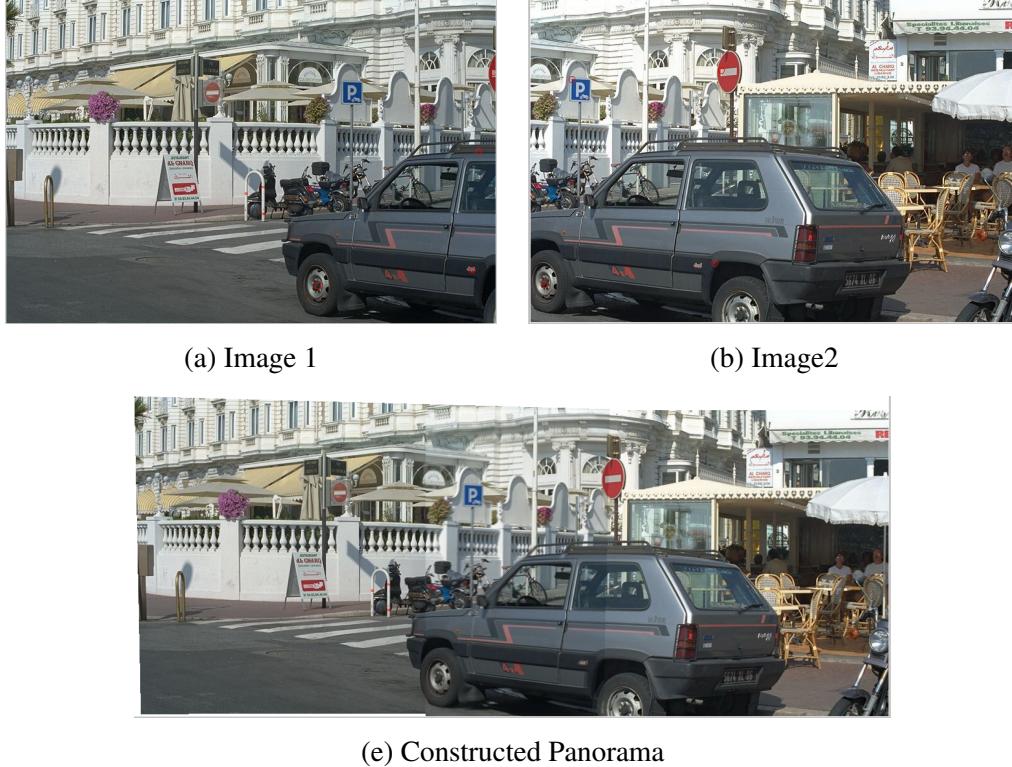


Figure 1. Constructed Panorama using 4 matching points

### 3.2. More than 4 points

Having more than four points (e.g., eight) will allow for a more robust estimation of the homography matrix.

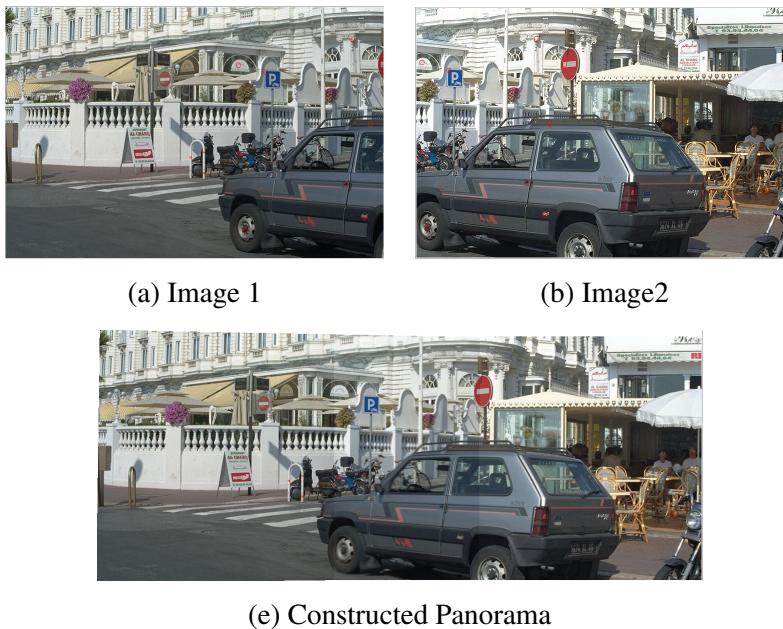


Figure 2. Constructed Panorama using 8 matching points: The transformation is more accurate.

### 3.3. Experiments on different images



(a) Image 1



(b) Image2



(e) Constructed Panorama



(a) Image 1



(b) Image2



(e) Constructed Panorama