Project 1 Report by

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How you apply the EM algorithm to vanishing point estimation, and a brief description of your results.

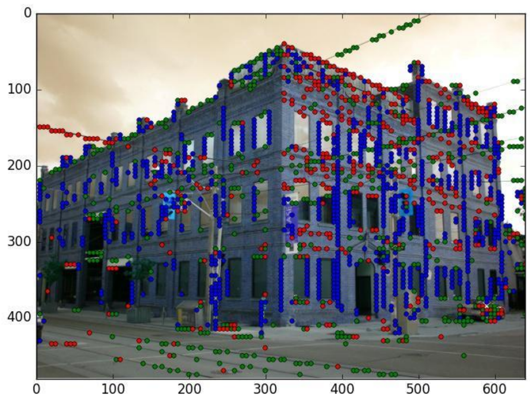
Before applying EM algorithm, we find the best initial camera orientation by calculating the minimum error. First, we search through β from -60° to 60° with 2° increment each iteration to find the best β. Then, we use the best β to find the best α, β and γ with the search range of β - 2° to β + 2° and -5° to 5° for α and γ. With the best α, β and γ, we then widen the search range for α to range α - 10° to α + 10° and γ to γ - 10° to γ + 10°, to make sure we get the optimal α and γ.

The error is calculated by the difference between the gradient direction of the original image (***Gdir***) and the predicted directions based on the α, β and γ for each x, y, z line (m_u=1,2,3) and fit into a normal distribution function with the ***sig*** and ***mu*** given. The error for random edge (m_u=4) is 1 / 2π. Each error value is multiplied with ***P_m_prior*** and sum up together. As we are finding the max log posterior term, we need to log the error sum for each pixel, then sum them up across 2000 pixels.

After we get the best initial rotation matrix R, we use it to go through EM algorithm in multiple iterations until the vanishing point euclidean distance changes is less than 0.001 for all 3 vanishing points.

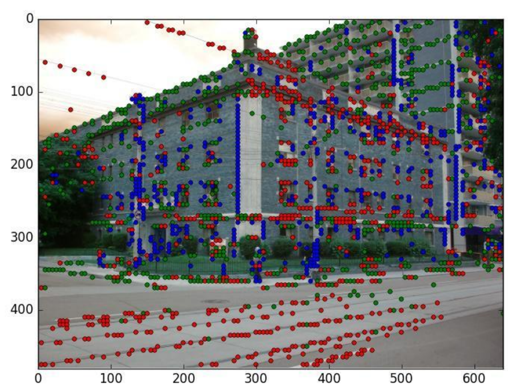
In the E steps, we find the error similarly as the step above, just instead of summing all the error for each pixel, we store the error for each m_u separately and normalize it to represent the weight to each vanishing point (m_u=1,2,3) or none of them (m_u=4).

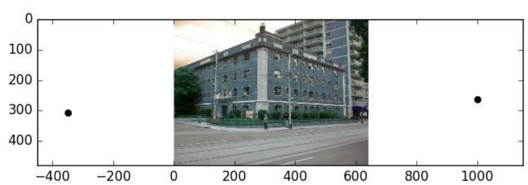
In the M steps, we need to minimize the error for the three vanishing points (m_u=1,2,3). The error is calculated by squaring the difference between predicted directions and original image gradient direction ***Gdir***.



Output images for P1030001.jpg

- Most of the pixels are assigned to the correct vanishing points.
- The vanishing points for the two axis are quite accurate.





Output images for P1080055.jpg

- This output seems to be better than the previous image, almost all the pixels seems to assign to the correct vanishing points.
- The vanishing points for the two axis are quite accurate for this picture too.