Final Report

Epipolar Geometry

In order for us to draw the Epipolar lines on both images (say name them, "left" and "right". Although the cameras probably weren't exactly side-by-side of each other's), we performed the following steps,

1. Choosing two point sets,
   We need to pick (manually) first two sets (one for calculating the fundamental matrix, and another as a control and error checking set) of interesting-matched points on both images.

2. Calculating the Fundamental matrix,
   We can use an Essential matrix, but in order to generalize to non-identity intrinsic matrices we use the fundamental matrix (the assumption of identity matrices is removed). Hence, the fundamental matrix will be $= K'^{-T}EK^{-1}$.
   F is a singular matrix, thus as for Homogeneous system solving, we find a solution via SVD (also enforce rank 2 constraint on F), which results in that that epipolar lines meet at the same point.

3. Calculate the Epipolar lines,
   In order to find the epipolar line $Ex = l$ of those corresponding matched points (via the previous fundamental matrix): $l' = Fx$, $l = F^T x'$.

4. Calculate the Symmetric Epipolar Distance (SED),
   In order for us to control\measure the error of our fundamental metric calculation, points matching sets, and also the epipolar lines calculation, we calculate the SED metric for the corresponding lines and their matched points as follows,
   According to "Fundamental Matrix Estimation: A study of Error Criteria",
   $SED_i^2 = d^2(p_i, l) + d^2(p_i', l') = \left(\frac{1}{l_1^2 + l_2^2} + \frac{1}{l_1'^2 + l_2'^2}\right) R_i^2$
   Where R is the "Algebraic distance", $R_i = R(p_i, p_i') = p_i^{-T} F p_i^{-'}$
   And, $SED = \frac{1}{N}\sum_{i=1}^{N}\sqrt{SED_i^2}$

   P.S. The above (in paper) equation came mainly from the point-line distance metric: $d = \frac{|ax_0+by_0+c|}{\sqrt{a^2+b^2}}$

5. As side notes,
   5.1. In order to calculate the Epipole ($Fe = 0$, solve via SVD).
   5.2. The above algorithm is applied for all the images in the data set (2 different ones).

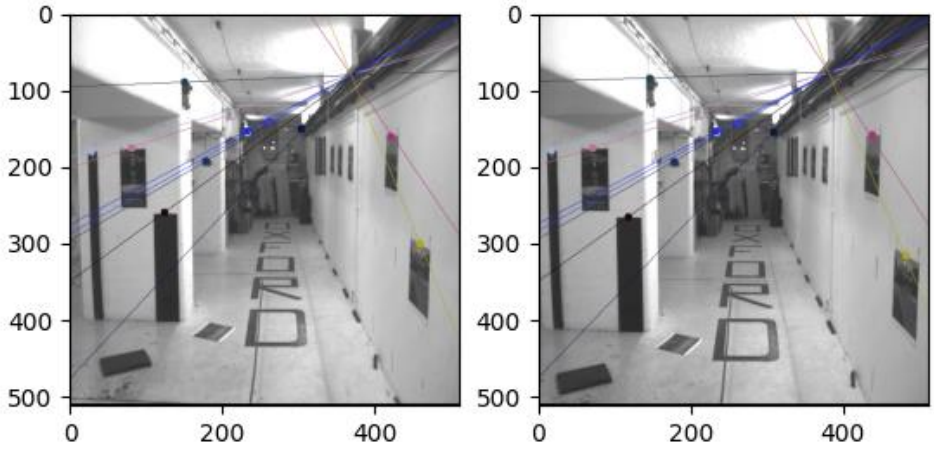
Hence, we got the bellow results,

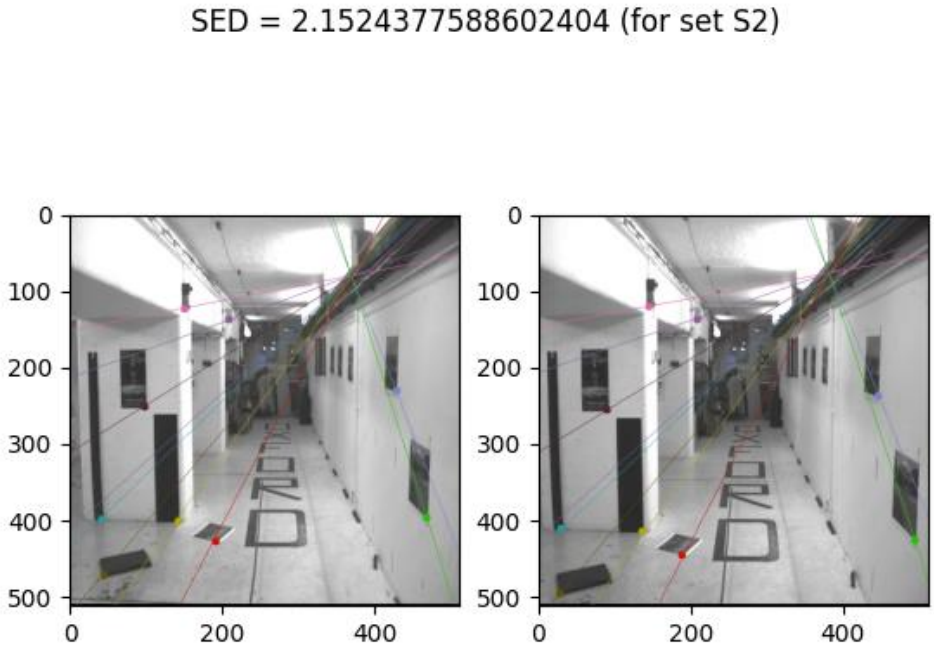
Hall,

Figure 1: Two Hall pictures taken from different cameras positions

Epipolar points and coresponding lines,

SED = 0.7351403898082045 (for set S1)



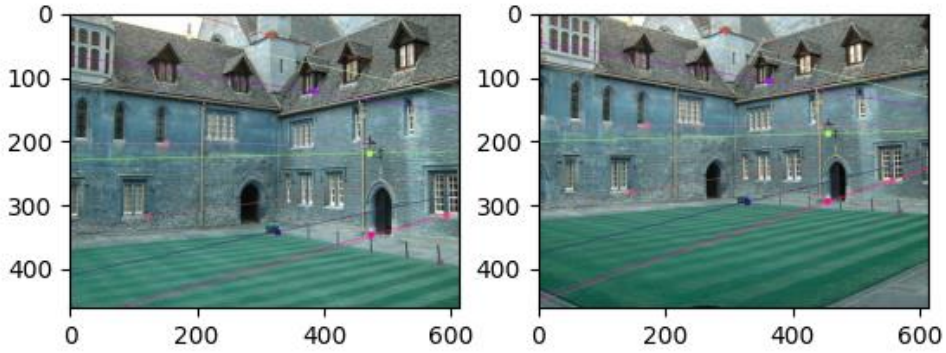


Building,

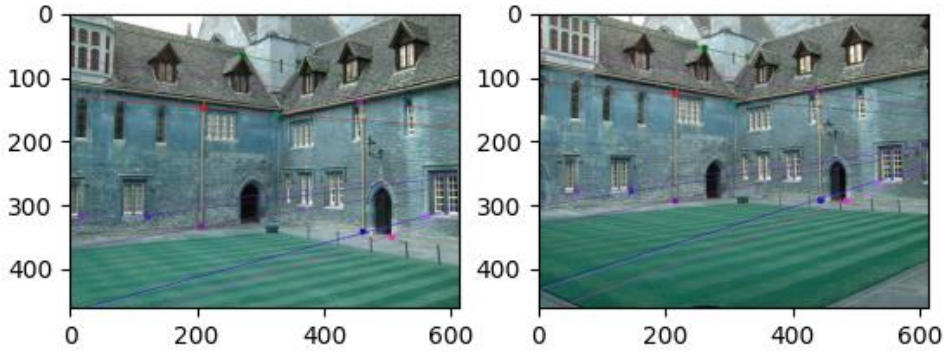
Figure 2: Two Building pictures taken from different cameras positions

Epipolar points and coresponding lines,

SED = 0.5434909630908302 (for set S1)



SED = 2.1869643158845835 (for set S2)



Results summary,

We can see that when the Fundamental matrix – F were calculated on the first S_1set, we got better results (via SED metric) than when matrix F was used on the second S_2 set (can be seen via the metric results).

SED metrics,

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First images set (hall) for points set s1, has a SED result of: 0.7351403898082045
First images set (hall) for points set s2, has a SED result of: 2.1524377588602404
First images set (building) for points set s1, has a SED result of: 0.5434909630908302
First images set (building) for points set s2, has a SED result of: 2.1869643158845835
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