Computer Vision - Assignment 3

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1. Homography: Let $(p_1, p_2, ..., p_n)$ be points in image I_1 and $(q_1, q_2, ..., q_n)$ be points in image I_2. We will prove that there exists a 3x3 matrix H such that $\forall i \in [1, n] : p_i = Hq_i$

   (a) Assumption: I_1 has the same coordinates system as the world.

   (b) Given: $C = COP_1 = COP_2$

   (c) Let M_1 denote the camera calibration matrix of I_1 and M_2 denote the camera calibration matrix of I_2.

   (d) We can then express any point P from A as $p = M_1 P, q = M_2 P$

   (e) From (a) and (b) we get that $p = M_1 * P = M_{int} * Projection * P$ and $q = M_2 * P = M_{int} * Projection * Rotation_2 * P$

   (f) Let $P' = Projection * P$ denote the projected point of P, then $p = M_{int} * P'$ and $q = M_{int} * R_2 * P'$

   (g) Since both M_{int} and $M_{int} * R_2$ are 3x3 matrices, then $p = M_{int} * [M_{int} * R_2]' * q$

   (h) The homography is $H = M_{int} * [M_{int} * R_2]'$

2. Detect the ground plane in a sequence using the optical flow:

   (a) Assumption: points on the ground plane have relatively the same optical flow orientation.

   (b) Method:

   - Build an histogram from the orientation (the O) matrix.
   - For every point with the common O value - color it as the ground plane.

3. Determine whether the camera is only rotating using the optical flow:

   (a) Assumption: If the camera is only rotating, then if the scene is static - all the points in the image have relatively the same optical flow orientation.

   (b) Method:

   - Build an histogram from the orientation (the O) matrix.
   - If the histogram "looks like" a spike - the camera is only rotating. That is, if the common value of O appears more than the second common by a factor of k, where k is our threshold.