Augmented Reality with AprilTags

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1. est pw.py

   Since we are defining the coordinate axis on the centre of the surface of the object, we can take the Z coordinate to be equal to 0. Hence, we can easily take the 4 corner points to be a city block distance away by a distance of side length/2.
   Hence, the corners can be represented as $(\pm s/2, \pm s/2)$

2. solve pnp.py

   Pass the 2 sets of coordinate points to the $est_homography$ function to retreive the homography matrix H.
   Normalise the homography matrix by dividing all terms by the final term of the matrix. Generate a new matrix H' defined as $K^{-1}H$.
   Perform singular value decomposition on H' to obtain R and t using the formulae provided.
   Convert the R and t obtained from camera centric coordinates to world centric coordinates.

3. Procrustes.py

   Find the centroids of the points as $Xbar$ and $Ybar$.
   Subract the coordinates from their centroids to find their true coordinates.
   Use an initial estimate of R and perform singular value decomposition to find R and hence find T.

4. solve p3p.py

   Choose 3 points at random of the 4 given points.
   Define the distances between the points - a, b and c as the euclidean distance between each pair.
   Find the calibrated coordinates of the points and hence find the j matrix.
   Find the angles α, β, γ
   Find the coefficients of the equation and hence solve for the roots.
   Find v to be the positive real roots of the equation and find u using v.
   Calculate the s vectors and hence the Pc_3d points
   Find R and t by calling the Procrustes function
   Reproject the R and t to find the 4th point and compare it with the existing Pc point to find the error.
   Choose the root that leads to least error and hence finalize the R and t.

Figure 1: Frame 1