Subowen Yan A20430537 CS512 - Summer HW5

1 a) outliers are the point is far from mean. the fundation problem is the outlier can change the real result

b) $E(\theta)=\sum_{i=1}^{n} \rho(d(x_i;\theta))$ least square objective function gives large weight to outliers which is totally opposite to robust estimation

c) $\rho(x)=\frac{x^2}{x^2+\sigma^2}$ the advantage is σ control function if $\sigma=0$ $\rho(x)=1$ if σ get large the $\rho(x)$ decrease faster

d) perform multiple experiments. choose best results. use small set in hope that at least one get will not have outliers.
each attempt should drawn small. It can avoid take large set of outliers

e) n = # points drawn at each evaluation, d = min # points needed to estimate model K = # trials t = distance threshold to identity inliers.
$k=\frac{\log(1-P)}{\log(1-W^n)}$ $w: \frac{\# \text{inliers}}{\# \text{points}}$

f) segmentation is trying to represent an image into small meaningful part merge is trying combine different cluster. spilt is doing opposite

g) kmeans partite observation into k clusters each cluster get mean. Gaussian mixture is similar to k-mean except measure distance is not same.

h) similar to k-means The mean computation is replaced with $m_j=\frac{\sum_{i=1} w(f_i-m_j)f_i}{w(f_i-m_j)}$ need iterative computation b/c m_j is not know

2 a) forward projection give world point and projection matrix compute image point calibration give world and image compute matrix reconstruction give image, projection matrix compute world point

forward projection is easiest, reconstruction is the hardest

b) the world point (3D) and corresponding image point (2D)

c) find projection matrix find internal and extrinsic parameters

d) $\begin{bmatrix} 1 & 2 & 3 & 4 \\ 1 & 0 & 3 & 4 \\ 1 & 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 2 \\ 3 \\ 1 \end{bmatrix} = \begin{bmatrix} 18 \\ 14 \\ 7 \end{bmatrix}$ $\begin{bmatrix} \frac{18}{7} \\ 2 \end{bmatrix}$ is Image cordinate

e) $\begin{bmatrix} 1 & 2 & 3 & 1 & 0 & 0 & 0 & 0 & -100 & -200 & -300 & -100 \\ 0 & 0 & 0 & 0 & 1 & 2 & 3 & 1 & -200 & -400 & -600 & -200 \\ & & & & & & & \vdots \end{bmatrix} \begin{bmatrix} m_1 \\ m_2 \\ \vdots \\ m_n \end{bmatrix} = \begin{bmatrix} 0 \\ \vdots \\ 0 \end{bmatrix}$

f) 6 point for non-planer 5 points for planar calibration
$AX=0$ use SVD $A=UDV^T$ solution: column of V
belongsto zero singular value

g) R^* is orthogonal matrix r_1, r_2, r_3 is orthogonal to each other
$r_1 \cdot r_2 = 0$ $r_2 \cdot r_3 = 0$ $r_3 \cdot r_1 = 0$ and $r_1 \times r_2 = r_3$ $r_2 \times r_3 = r_1$ $r_1 \times r_3 = r_2$
to get result

h) use mean square error: $E(K^* R^*, T^*) = \frac{1}{n} \left(\sum_{i=1}^{n} \left(x_i - \frac{m_1^T P_i}{m_3^T P_i}\right)^2 + \sum_{i=1}^{n} \left(y_i - \frac{m_2^T P_i}{m_3^T P_i}\right)^2 \right)$

i) planar calibration step: 1) estimate 2D homogerphy between calibration target and image 2) estimate intrinsic parameters from different views 3) compute extrinsic parameters.
The difference is all points in same planer in planar calibration.
The non-planer does not

j) M has r_1, r_2, r_3, H have r_1, r_2 in projection matrix,
we assume $Z=0$ when we do computation