ASSIGNMENT 5

An ovtrier is a point de that is not part of the data any night be harmful to the solution

All the points in the data that are close to each other flot nicely fit the model. They do not affect the server much.

But when we have one point which is different, the error too is very large and because of this the point becomes very influencial and we do not want the wrong points to be not the most influencial.

b) The objective function used for robust estimation is $E(\theta) = \sum_{\sigma} \left(d(\pi; \theta) - 0 \right)$

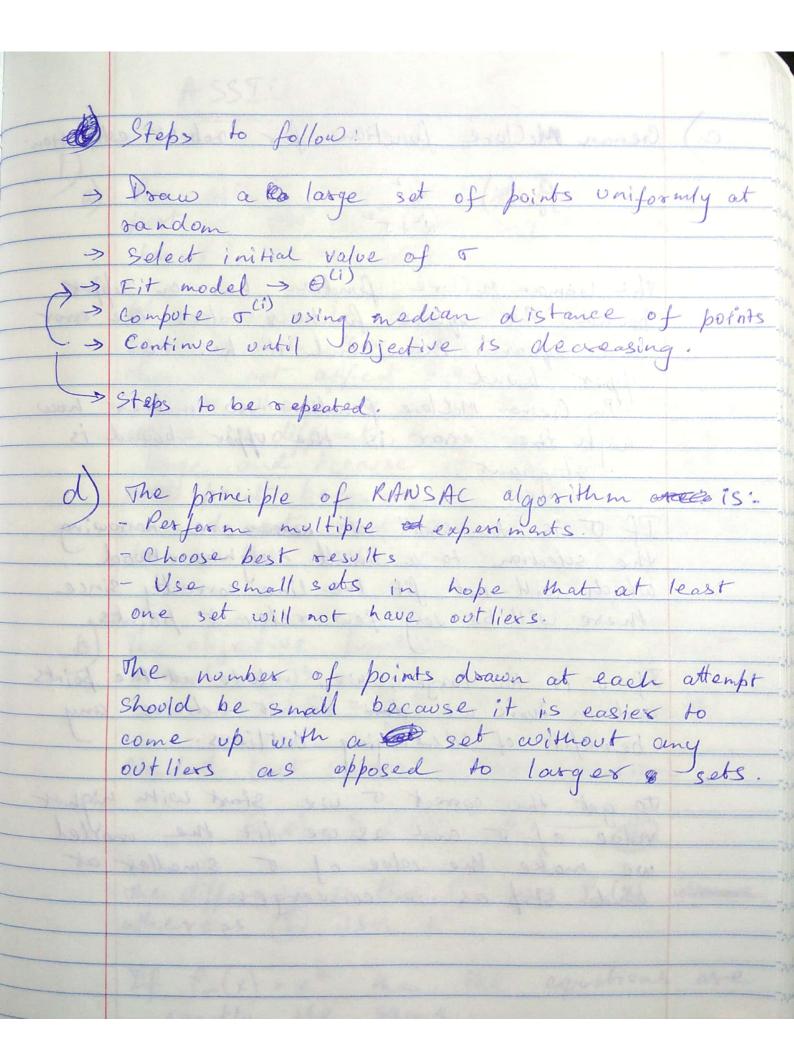
Standard least squares objective function

The difference is that (1) uses $f_{\sigma}(\mathbf{x})$ whereas (2) uses \mathbf{x}^2 .

If fo(x) > x then the equations are exactly the same.

c) Greman prellure function for robust estimation $\int_{\mathcal{C}} (x) = x^2$ $x^2 + \sigma^2$ the Geman McClure function has an upper bound. The square functions takes the error and squares them and it has no upper bound.

In Geman McClure function no matter how high the error is the upper bound is I stagnant. If T is too small, we recover are norsowing the solection to a small neighbourhood which will not fit the line correctly since these will be very few relevant points. If o is too large, we include all the points and in twon we dow do not acheive any benefit of identifying outliers. value of t and as we fit the model we make the value of 5 smaller at each stop as we converge.



e) Parameters of the RAWSAC algorithm! n = monter of points drawn at each

evaluation

d = minimum purp number of points needed to

estimate model

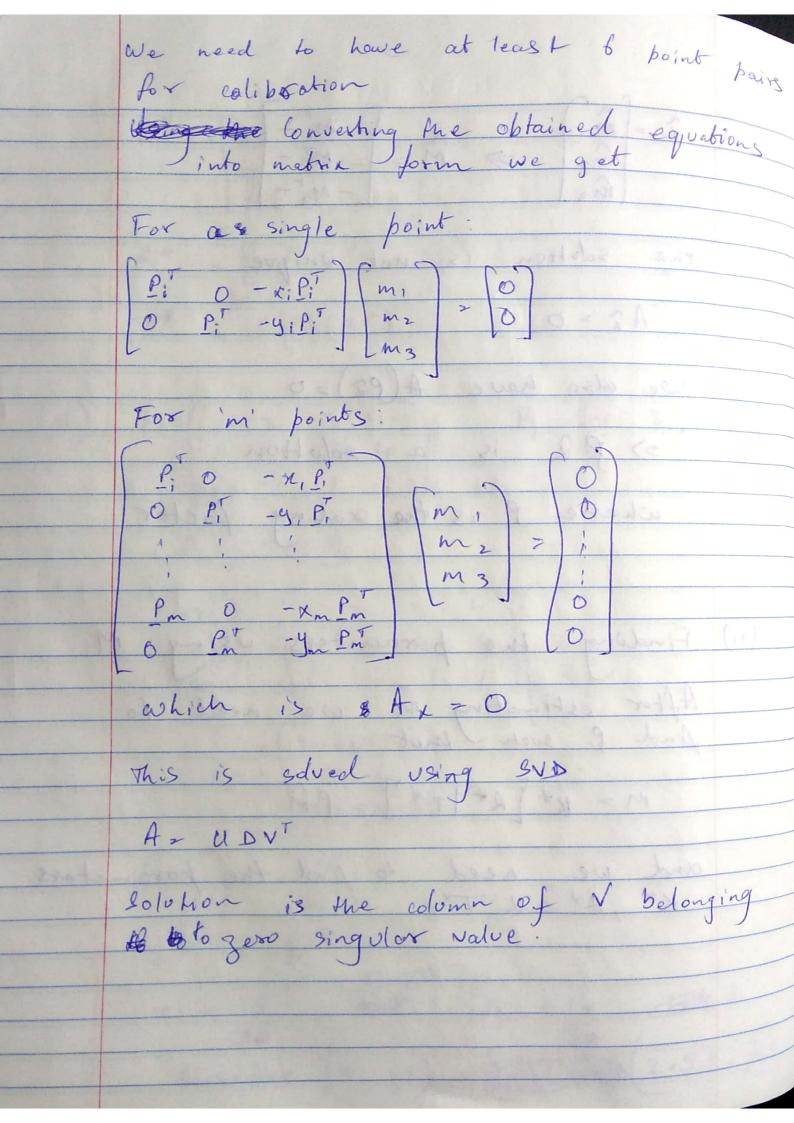
K = number of trials

t = distance threshold to identify inliers. Number of totals, k = log(1-p) log(1-wn)f) Objective of image segmentation! > separate objects from background > find contours of objects > label each pixel in the image with class tabel. each pixel in a se parate duster was start with come de compracte co o chartonith and merge dusters with small distance whoseas in divisive approach we start with all pixels in one cluster and split distance large distance les between them.

K means is used for pastitioning in observations into K dostors in which each observation belongs to me chester prototype of the cluster. The Garssian mature node (is similar to x-means but with different in easure The mean-shift algorithm is similar to k-means whose it basically Breaker 10= States, adds weights to each distance and the closer me data point is to the cost or , the highes weight it a) forward projection lois when P'i and on one given and inage point needs to be computed. Calibration & is when image and world points are given and M needs to be so computed. Reconstruction is when image point and on are given and world point needs to be Compoted.

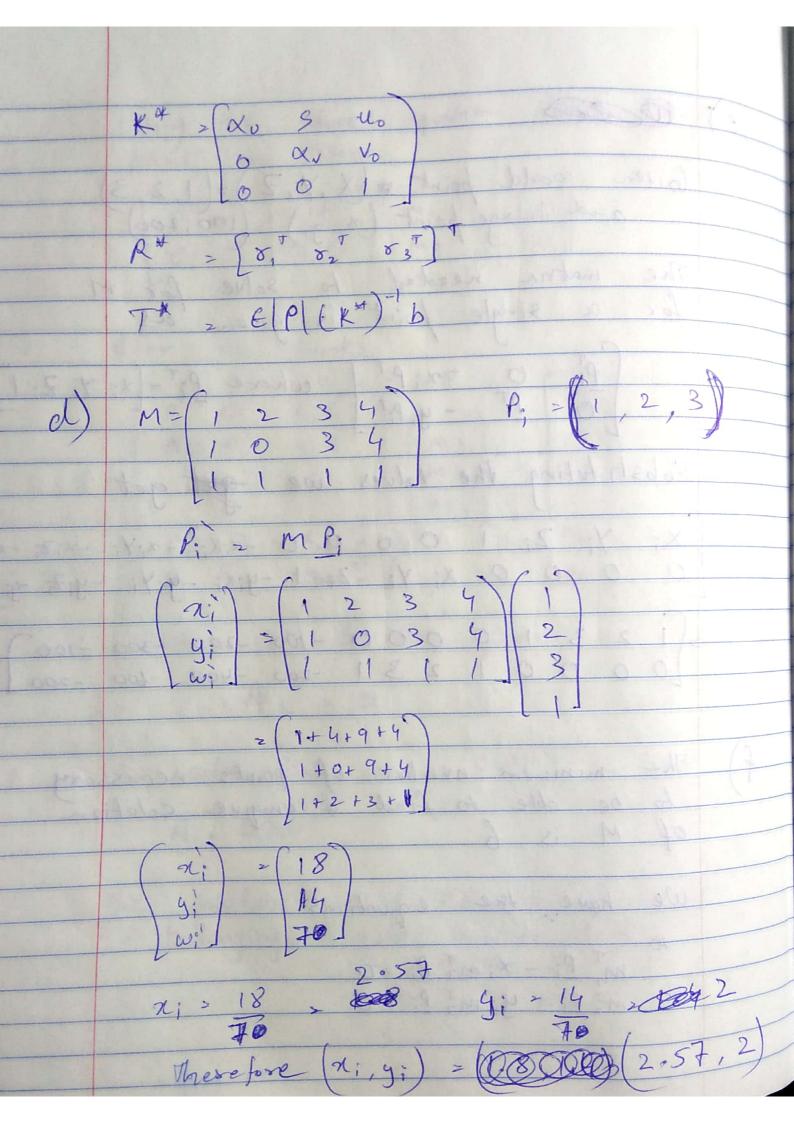
Forward projection is the easienst Reconstruction is the hardost.

	ASSIBNMENT 5
2)	
b)	The necessary input for comera colibration is two files in which world each row will have a world point and a corresponding image point.
	calibration is two files in which worth
	each row will have a world
	point and a corresponding image point.
	point and a corresponding image point. in meters and pixals respectively.
1	
()	The stops in non coplanar ealibration
	The stops in non coplanar ealibration algorithm are:
,,	
1	Finding the projection matrix m
	Using P; = mP; where P; = xi
	31 31
	Using $P_i = mP_i$ where $P_i = \begin{cases} \pi_i \\ y_i \end{cases}$ $\begin{cases} P_i \neq \pi_i \\ y_i \end{cases}$ $\begin{cases} g_i \\ \vdots \end{cases}$
	we took on
	$\begin{array}{c c} \chi_{1} & -m_{1} - & & \\ \hline \chi_{1} & -m_{2} - & & \\ \hline & & -m_{3} - & \\ \hline \end{array}$
	9i > - mz
	- M3
	$ w_i $
	TO d'= v. mTO. mTO. TO. TO. 20
	$A_i = m_i^T P_i$ $A_i' = \chi_i' = m_i^T P_i$ $M_i' = \chi_i' = m_i^T P_i$ $M_i' = \chi_i' = $
	J1 = 1 6
	w: = m3 P; y: = q; m P: - y: m P: > D
1	$w_{i}^{2} = m_{3}^{2} P_{i}^{2}$ $y_{i}^{2} = y_{i}^{2} + y_{i}^{2} = y_{i}^{2} + y_{i}^$
1	For each point in m we have 2 equations
1	with 12 unknowns



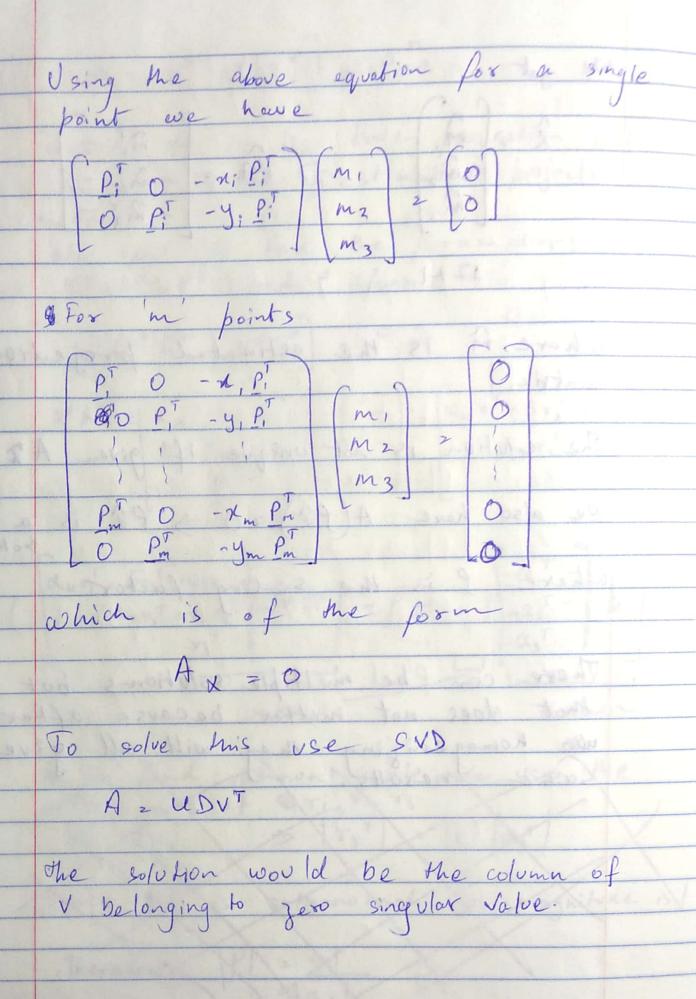
 $\hat{z} = \hat{m}$ \hat{m}_2 \hat{m}_3 \hat{m}_4 \hat{m}_5 \hat{m}_5 \hat{m}_7 \hat{m}_8 \hat{m}_8 \hat{m}_8 \hat{m}_8 \hat{m}_8 \hat{m}_8 \hat{m}_8 \hat{m}_8 \hat{m}_8 me solution is not unique we also have A(P)=0 s) pû is a solution where I is the scaling factor -- K P 1 0 Finding the parameters using M After estimating in we need to m= K*[R* | T*] = PM and we need to find the parameters

K* , R* and T*



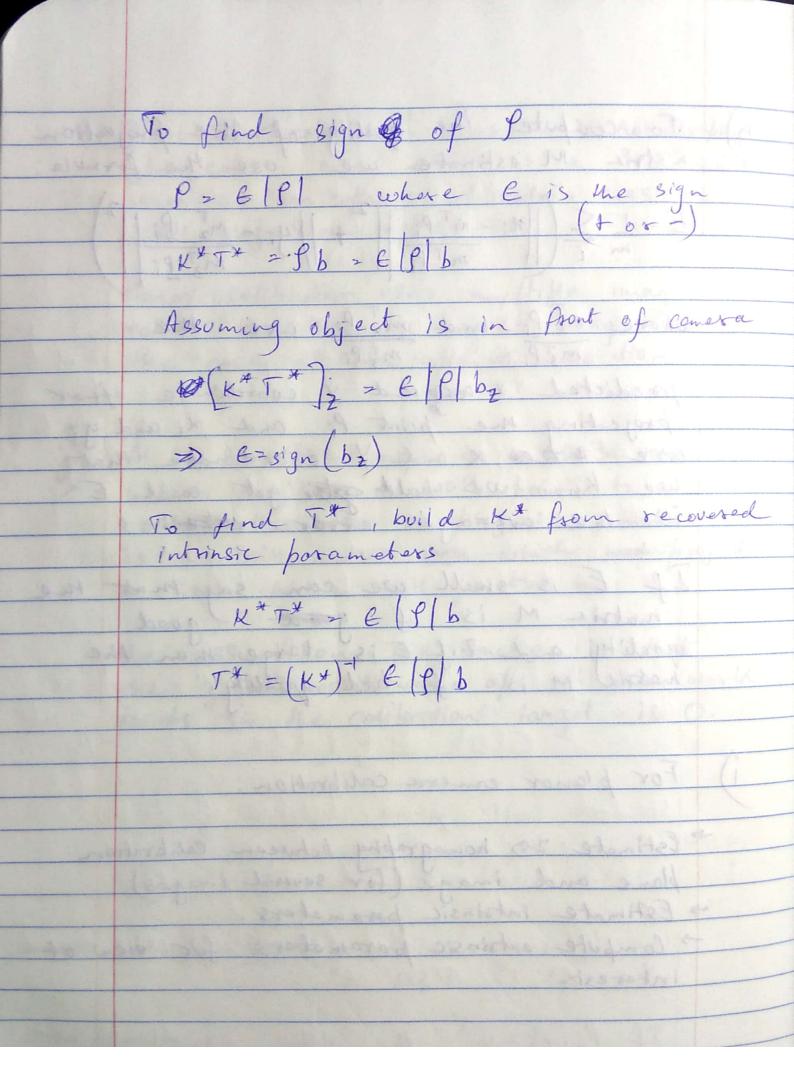
e) Deckoo K sala s - us Jan Given world point & (X, Y, Z) = (1, 2, 3) and image point (x, yi) = (100, 200) The matrix needed to solve for M for a single point is given as P; 0 - x; P; where P; = [x; Y; Z; 1]

O P; - y; P; T Substituting the values we get get X; Y; Z; 1 0 0 0 0 -x;X; -x;Y; -x;Z; -x;
0 0 0 0 X; Y; Z; 1 -y;X; -q;Y; -y;Z; -y; $\begin{bmatrix} 1 & 2 & 3 & 1 & 0 & 0 & 0 & 0 & -100 & -200 & -300 & -100 \\ 0 & 0 & 0 & 0 & 1 & 2 & 3 & 1 & -200 & -400 & -600 & -200 \end{bmatrix}$ The minimum number of points necessary to be able to find a unique solution We have the equations m. P: - X; m3 P: =0 m2 Pi - yi m3 Pi = 0



we get montage souls set projet where m is the estimated projection matrix The solution is not unique if given A \$ =0 we also have A(PL) > 0 > PL is a solutionwhere f is the scaling factor There can be multiple solutions but that does not matter because after some results. Men will all give the A perfording part of backing A

We use the orthogonality frinciple of 81, 82, 83 which means 01/08/1, 82 20 82.83 20 18/1, 83 20 Using mis principle we get me following 14 Tret 1 (1 2) 1 (1 2) 1 4 1 1 = |P|2 a. as Using Raf. Pas Vo = 19/2 a2. a3 using Pat. Pat) dv= fag. a 2 - Vo2 (using Par. Saz) S=1 p4 (a;xaz). (azxaz) using Pa, X Pas)



h) To compute the quality of the projection matrix M estimate we use the formula:

E = 1 \[
\begin{align*}
& \begin{align*}
& m_1^T P_1 & \begin{align*}
& m_2^T whore m, P; and m2 P; are the m3 P; predicted & ange and y coordinate after projecting me point P; and x; and y; are to be ea x and y coordinate that we know we should get get and E If E is small we can say that the hatrix M is of good good good the hard the harries and this E is large men the hatrix M is of bad quality. i) For planor canera calibration: Estimate 20 homography between Calibration blane and image (for several images) > Estimate intrinsic parameters. To compute autsinsic parameters for view of interest.

The planar calibration uses a 20 homography (brojective map) which is a 3x3 matrix whereas non coplanar calibration uses a 3x4 projection matrix. Planax calibration uses multiple images rather than a single image as in me case of non coplanax calibration has do not affect the series in Albert when we have one po A 2D projective map is a 3+3 matrix which projects a 2DM point to a 2011 point whereas a projection matrix M is a 324 matrix cotic which may projects a 3 DM to a 2DM point. The assumption we make is that the 'z' poor wordinate of all the world points on the calibration target is O. Standard last sports objective faction the difference in Make (1) can Pela) whereas (2) uses x2. RF P_(+) = x has the equations