(1) After considering 10 images of chessboard.
Now let us consider a image from the 10 images and mark the pixel coordinates and as well as the world co.ordinates of any 6 points on the chess board.

Where, the world coordinates are represented in the format of (x_w, y_w, z_w)
where, the depict the following co.ordinates from the images selected.
(4, 2.2) (5, 3.2) (6, 3.1) (4, 3.2) (5, 4.0) (6, 4.3)
Now, considering the pixel coordinates from the images selected they can be represented as following format of (x_i, y_i)
↳ (255, 180) (320, 130) (420, 160) (310, 115) (290, 155)
(310, 200)

Where, the multiplication can be performed among the represented co.ordinates is depicted as below:-

$$\begin{bmatrix} x_i \\ y_i \\ 1 \end{bmatrix} = \begin{bmatrix} m_{11} & m_{12} & m_{13} & m_{14} \\ m_{21} & m_{22} & m_{23} & m_{24} \\ m_{31} & m_{32} & m_{33} & m_{34} \end{bmatrix} \begin{bmatrix} x_w \\ y_w \\ z_w \\ 1 \end{bmatrix}$$

After performing the above operation this can result as =)

$$x_i = \frac{m_{11} x_w + m_{12} y_w + m_{13} z_w + m_{14}}{m_{31} x_w + m_{32} y_w + m_{33} z_w + m_{34}} \longrightarrow (1)$$

$$y_i = \frac{m_{21} x_w + m_{22} y_w + m_{23} z_w + m_{24}}{m_{31} x_w + m_{32} y_w + m_{33} z_w + m_{34}} \longrightarrow (2)$$

i,e

$$\rightarrow x_w m_{11} + y_w m_{12} + z_w m_{13} + m_{14} - x_i \left[x_w m_{31} + y_w m_{32} + z_w m_{33} + m_{34} \right] = 0$$

$$\rightarrow x_w m_{21} + y_w m_{22} + z_w m_{23} + m_{24} - y_i \left[x_w m_{31} + y_w m_{32} + z_w m_{33} + m_{34} \right] = 0$$

Now, Representation of the following in a matrix format:

$$\begin{bmatrix} x_w & y_w & z_w & 1 & 0 & 0 & 0 & 0 & -x_c x'_w \\ 0 & 0 & 0 & 0 & x_w & y_w & z_w & 1 & -y_c x_w \end{bmatrix}$$

Writing the equations for the '6' points

$$\begin{bmatrix}
4 & 2.2 & 0 & 1 & 0 & 0 & 0 & 0 & -1024 & -588.8 & 0 & -255 \\
0 & 0 & 0 & 0 & 4 & 2.2 & 0 & 1 & -736 & -423.2 & 0 & -180 \\
5 & 3.2 & 0 & 1 & 0 & 0 & 0 & 0 & -163 & -1001.6 & 0 & -320 \\
0 & 0 & 0 & 0 & 5 & 3.2 & 0 & 1 & -655 & -406.1 & 0 & -130 \\
6 & 3.1 & 0 & 1 & 0 & 0 & 0 & 0 & -2532 & -266 & 0 & -420 \\
0 & 0 & 0 & 0 & 6 & 3.1 & 0 & 1 & -978 & -489 & 0 & -160 \\
4 & 3.2 & 0 & 1 & 0 & 0 & 0 & 0 & -1248 & -1060.8 & 0 & -310 \\
0 & 0 & 0 & 0 & 4 & 3.2 & 0 & 1 & -464 & -394.4 & 0 & -115 \\
5 & 4.0 & 0 & 1 & 0 & 0 & 0 & 0 & -1445 & -1184.9 & 0 & -290 \\
0 & 0 & 0 & 0 & 5 & 4.0 & 0 & 1 & -775 & -635.5 & 0 & -155 \\
6 & 4.3 & 0 & 1 & 0 & 0 & 0 & 0 & -1860 & -133.3 & 0 & -310 \\
0 & 0 & 0 & 0 & 6 & 4.3 & 0 & 1 & -1212 & -868.3 & 0 & -200
\end{bmatrix}$$

let,

A = Matrix of all known values

Eigen vector corresponding to the smallest eigen value of $A \cdot A^T$ is Matrix 'M'

i,e Smallest & Least Eigen Value of

$$A \cdot A^T \Rightarrow \lambda = 0.006$$

i,e
$$\begin{bmatrix} m_{11} \\ m_{12} \\ m_{13} \\ m_{14} \\ m_{21} \\ m_{22} \\ m_{23} \\ m_{24} \\ m_{31} \\ m_{32} \\ m_{33} \\ m_{34} \end{bmatrix} = 0.0$$

i,e

then,

$$m = \begin{bmatrix} -0.00 & -0.00 & 0.00 & 0.00 \\ 0.00 & 0.00 & 0.00 & 0.00 \\ 0.00 & 0.0015 & 0.0245 & 3.111 \end{bmatrix}$$

QR Representation of the Matrix 'M' gives the intrinsic & extrinsic parameters.

QR decomposition of 'M'

$$\text{Intrinsic Matrix} = \begin{bmatrix} 0.413 & -0.02 & 0.10 \\ 0 & 0.532 & -0.07 \\ 0 & 0 & 0.64 \end{bmatrix}$$

$$\text{Extrinsic Matrix} = \begin{bmatrix} -0.34 & 0.25 & 0.4 \\ 0.40 & -0.37 & 0.03 \\ 0.22 & 0.5 & 0.52 \end{bmatrix}$$

Considering, the Pixel density of camera$(m_x) = 0.175$

↳ Comparing the derived Intrinsic matrix with

$$\begin{bmatrix} m.f & 0 & 0.23 \\ 0 & mf & -0.18 \\ 0 & 0 & 1 \end{bmatrix} \Rightarrow m.f = 0.52$$

i,e

$$f = \frac{0.52}{0.175} \cancel{cm}$$

$\therefore$ focal length$(f) = 29.7$ cm

i,e Principal point $P(P_x, P_y) = (0.23, -0.18)$

2. While we select a pair a images as a source and destination.

Where we select a four points from the source image & corresponding from the destination image.

i,e

	P	Q	R	S
Source	(2,2)	(7,6)	(9,3)	(10,5)
Destination	(1,2)	(3,6)	(8,4)	(5,3)

As we know,

$$\underbrace{\begin{bmatrix} x_s & y_s & 1 & 0 & 0 & 0 & -x_d x_s & -x_d y_s & -x_d \\ 0 & 0 & 0 & x_s & y_s & 1 & -y_d x_s & -y_d y_s & -y_d \\ \vdots & & \vdots & & & & \vdots & \vdots & \vdots \\ x_s & y_s & 1 & 0 & 0 & 0 & -x_d y_s & -x_d y_s & -x_d \\ 0 & 0 & 0 & x_s & y_s & 1 & -y_d x_s & -y_d y_s & -y_d \end{bmatrix}}_{A} \underbrace{\begin{bmatrix} h_{11} \\ h_{12} \\ h_{13} \\ h_{21} \\ h_{22} \\ h_{23} \\ h_{31} \\ h_{32} \\ h_{33} \end{bmatrix}}_{H}$$

$AH = 0$

where, 'H' is a Homography matrix.

Now, if we simplify the above 'A' with the help of the corresponding x, y coordinates Eigen vector of smallest eigen value of $A^T.A$ gives the homography matrix 'H'.

$$A = \begin{bmatrix} 4 & 2 & 1 & 0 & 0 & 0 & -4 & -2 & -1 \\ 0 & 0 & 0 & 4 & 2 & 1 & -8 & -4 & -2 \\ 7 & 6 & 1 & 0 & 0 & 0 & -21 & -18 & -3 \\ 0 & 0 & 0 & 7 & 6 & 1 & -42 & -36 & -6 \\ 9 & 3 & 1 & 0 & 0 & 0 & -72 & -24 & -8 \\ 0 & 0 & 0 & 9 & 3 & 1 & -24 & -12 & -4 \\ 10 & 5 & 1 & 0 & 0 & 0 & -50 & -25 & -5 \\ 0 & 0 & 0 & 10 & 5 & 1 & -15 & -15 & -3 \end{bmatrix}$$

When $A.A^T$ is calculated

$$A^T = \begin{bmatrix} 4 & 0 & 7 & 0 & 9 & 0 & 10 & 0 \\ 2 & 0 & 6 & 0 & 3 & 0 & 5 & 0 \\ 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 \\ 0 & 4 & 0 & 7 & 0 & 9 & 0 & 10 \\ 0 & 2 & 0 & 6 & 0 & 3 & 0 & 5 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 \\ -4 & -8 & -21 & -42 & -72 & -24 & -50 & -15 \\ -2 & -4 & -18 & -36 & -24 & -12 & -25 & -15 \\ -1 & -2 & -3 & -6 & -8 & -4 & -5 & -3 \end{bmatrix}$$

$$A \cdot A^T = \begin{bmatrix} 42 & 42 & 164 & 246 & 387 & 124 & 306 & 93 \\ 42 & 105 & 246 & 533 & 688 & 291 & 520 & 237 \\ 164 & 246 & 860 & 1548 & 2050 & 732 & 1616 & 591 \\ 246 & 533 & 1548 & 3182 & 3936 & 1546 & 3030 & 1289 \\ 387 & 688 & 2050 & 3936 & 5915 & 2048 & 4346 & 1464 \\ 124 & 291 & 732 & 1546 & 2048 & 827 & 1520 & 650 \\ 306 & 570 & 1616 & 3030 & 4346 & 1520 & 3276 & 1140 \\ 93 & 237 & 594 & 1289 & 1464 & 658 & 1140 & 555 \end{bmatrix}$$

The Calculated least eigen value of $A \cdot A^T$ is $\lambda = 0.002$ # The eigen vector corresponding to the calculated eigen value $\lambda = 0.002$ is

$$[0.431, 0.427, -0.641, -0.473, -0.710, -0.57, 0.99, 2, 0]$$

Homography Matrix (H) $= \begin{bmatrix} 0.431 & 0.427 & -0.641 \\ -0.473 & -0.710 & -0.57 \\ 0.99 & 1 & 0 \end{bmatrix}$