Since $\vec{x}'^T F \vec{x} = 0$ for matching pairs x & x'

we can rearrange the equation s.t.

$$A' \cdot f = \vec{0}$$

where $f = \begin{bmatrix} f_{11} \\ f_{12} \\ \vdots \\ f_{33} \end{bmatrix}$ and $F = \begin{bmatrix} f_{11} & f_{12} & f_{13} \\ \vdots & & \\ \cdots & \cdots & f_{33} \end{bmatrix}$

and $\vec{x}' = (x', y', 1)$ $\vec{x} = (x, y, 1)$

and $A' = [x'x, x'y, x', y'x, y, y', x, y, 1]$

For given n-pair of points, we can stack such (A') to form A matrix s.t.:

$$A = \begin{bmatrix} x_1'x_1 & x_1'y_1 & \cdots & \cdots & 1 \\ \vdots & & & & \\ x_n'x_n & \cdots & \cdots & \cdots & 1 \end{bmatrix}$$

And we solve for f s.t. $\|Af\|$ is minimized.

In SVD of $A = UDV^T$. The last column of V gives us the f which minimizes $\|Af\|$, but gives $\|f\| = 1$ but the F matrix is singular. Hence as an approximation we perform SVD on $\hat{F}$ from above step s.t. $\hat{F} = UDV^T$ and recompute F after replacing smallest singular value of D by zero. This new F is closest to $\hat{F}$ in terms of least squares.