$$\Delta p = H^{-1} \sum_{x} \left[\nabla I \frac{\partial W}{\partial p} \right]^T [T(x) - I(W(x;p))]$$

, where H is Hessian Matrix, ∇I is image ingredient.

In simple translation (where $W(x;p) = x+p$), this $\frac{\partial W}{\partial p}$ becomes a constant, simplifying the iterative update process.
The Lucas-Kanade algorithm is a linear least-squares problem

$$\begin{bmatrix} \sum I_x^2 & \sum I_x I_y \\ \sum I_x I_y & \sum I_y^2 \end{bmatrix} \begin{bmatrix} u \\ v \end{bmatrix} = -\begin{bmatrix} \sum I_x I_y \\ \sum I_y I_t \end{bmatrix}$$

In both cases, the summation and matrix setup capture the intensity gradients and displacements, allowing us to solve for u and v (the translation parameters). Thus, both solution are equivalent in the case of translation.

$$\Delta p = \begin{bmatrix} u \\ v \end{bmatrix}, \quad \frac{\partial W}{\partial p} = \begin{bmatrix} \frac{\partial W_x}{\partial u} & \frac{\partial W_x}{\partial v} \\ \frac{\partial W_y}{\partial u} & \frac{\partial W_y}{\partial v} \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$H = \sum_x \left[\nabla I \frac{\partial W}{\partial p} \right]^T \left[\nabla I \frac{\partial W}{\partial p} \right] = \sum_x \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} \frac{\partial I}{\partial x} \\ \frac{\partial I}{\partial y} \end{bmatrix} \begin{bmatrix} \frac{\partial I}{\partial x} & \frac{\partial I}{\partial y} \end{bmatrix} \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} \sum I_x I_x & \sum I_x I_y \\ \sum I_y I_x & \sum I_y I_y \end{bmatrix}$$

$$\begin{bmatrix} u \\ v \end{bmatrix} = \begin{bmatrix} \sum I_x^2 & \sum I_x I_y \\ \sum I_y I_x & \sum I_y^2 \end{bmatrix}^{-1} \sum_x \begin{bmatrix} I_x \\ I_y \end{bmatrix} [T(x) - I(W(x;p))]$$

$$\begin{bmatrix} \sum I_x^2 & \sum I_x I_y \\ \sum I_y I_x & \sum I_y^2 \end{bmatrix} \begin{bmatrix} u \\ v \end{bmatrix} = -\begin{bmatrix} \sum I_x I_y \\ \sum I_y I_t \end{bmatrix}$$