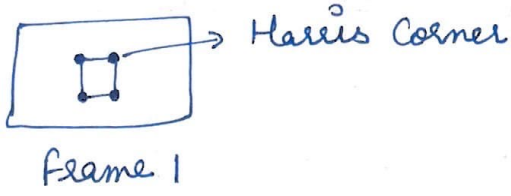
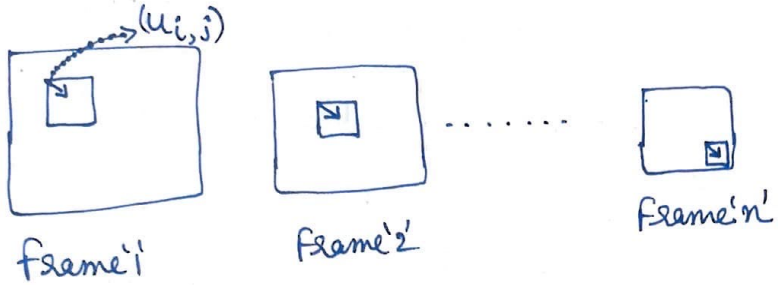
Kanade-Lucas-Tomasi (KLT Method)

Steps for tracking object using KLT Method :-

1. Detect Harris Corners in first frame :-

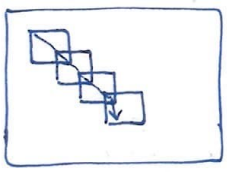


2. ~~Each~~ for each harris Corner, Compute motion Vector (translation or affine) between Consecutive frames :-



This Step is Called as alignment Step; because in this Step we are going to align the harris Corner with the help of motion Vectors.

3. Link motion Vectors in Successive frames to get tracks from each harris points.



Frame 1 - 2 - 3 - 4 - ..... (Vector for Point 1 (Harris point) are linked to form one track)

Note : we can find motion vectors for multiple objects. Here, above example is Shown for one object.

4. Introduce new Harris Points after 'n' (n is after every 10-15 frames) by applying Harris detector.
5. Track new and old harris Points.

Finding Alignment Of Lucas – Kanade :-

Goal :- Given template $T(x)$ → find 'p' to minimize :

$$\sum_x \left[I(W(x;p)) - T(x) \right]^2$$

Step 1 :- Wrap the image with initial estimate (I with $W(x:p)$)

Step 2 :- Subtract from the template $-T(x)$

$$\text{Error} = I(W(x:p)) - T(x)$$

Step 3 :- Compute the gradient ∇T

Step 4 :- Evaluate Jacobian : $\partial W / \partial p$.

Step 5 :- Multiply Jacobian with gradient : $\nabla T \cdot \frac{\partial W}{\partial p}$

Step 6 :- Compute Inverse Hessian Matrix : H^{-1}

Step 7 :- ~~Com~~ Multiply with error :-

$$\sum_x \left[\nabla T \frac{\partial W}{\partial p} \right]^T \left[I(W(x:p)) - T(x) \right]$$

Step 8 :- Compute ∇p :

$$\nabla p = H^{-1} \sum_x \left[\nabla T \cdot \frac{\partial W}{\partial p} \right]^T \cdot \left[I(W(x:p)) - T(x) \right]$$

Step 9 :- update Parameters :- $p \rightarrow p + \Delta p$.