16720 HW 3 Write-up

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- **Q1.1**

To minimize: $\|I_{t+1}(x+p) - I_t(x)\|^2$

Using Taylor Series Expansion: $\approx \|I_{t+1}(x') + \frac{\partial I_{t+1}(x')}{\partial x'^T}\frac{\partial W(x;p)}{\partial p^T}\Delta p - I_t(x)\|^2$

Comparing this with: $\Delta p = \text{argmin}_{\Delta p}\|A\Delta p - b\|^2$
$\Rightarrow$
$A = \frac{\partial I_{t+1}(x')}{\partial x'^T}\frac{\partial W(x;p)}{\partial p^T}$ and $b = I_t(x) - I_{t+1}(x')$

$\Rightarrow$
In the given case, since Δp has only x and y translation components
$\frac{\partial W(x;p)}{\partial p^T} = \begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}$
$\Rightarrow$
To find: $\Delta p = \text{argmin}_{\Delta p}\|A\Delta p - b\|^2$
On differentiating: $2(A\Delta p - b)^T A = 0$
Hence, Condition - $A^T A$ should be invertible to a get a unique solution of Δp

- **Q1.3** Report your tracking performance (image + bounding rectangle) at frames 1, 100, 200, 300 and 400

Figure 1: Lucas-Kanade Tracking with One Single Template

- **Q1.4** Template Correction Results

With Template Correction , Without Template Correction

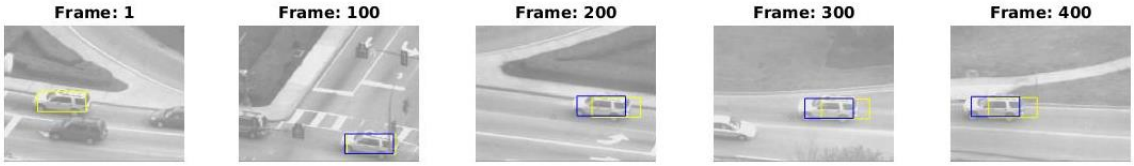

Figure 2: Lucas-Kanade Tracking with Template Correction

- **Q2.1**

$\mathrm{I}_{t+1}(x) = I_t(x) + \sum_{k=1}^{K} w_k B_k(X)$

$\Rightarrow \sum_{k=1}^{K} w_k B_k(X) = I_{t+1}(x) - I_t(x)$

$\Rightarrow w_1 B_1(x) + w_2 B_2(x) + .. + w_k B_k(x) + .. + w_K B_K = I_{t+1}(x) - I_t(x)$

Multiplying both sides by $B_k(x)$

$\Rightarrow B_k(x) w_1 B_1(x) + .. + B_k(x) w_k B_k(x) + .. + B_k(x) w_K B_K(X) = B_k(x)(I_{t+1}(x) - I_t(x))$

Considering orthogonality

$\Rightarrow w_1 0 + .. + w_k \|B_k(x)\|^2 + .. + w_K 0 = B_k(x)(I_{t+1}(x) - I_t(x))$

$\Rightarrow w_k = \frac{B_k(x)}{\|B_k(x)\|^2}(I_{t+1}(x) - I_t(x))$

- **Q2.3** Please report the performance of this tracker at frames 1, 200, 300, 350 and 400 (the frame + bounding box), i

Normal Lucas Kanade , Lucas Kanade with Appearance Basis

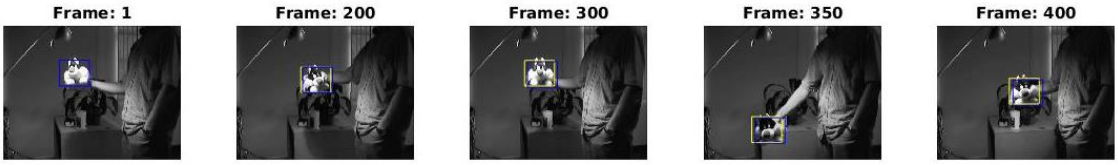

Figure 3: Lucas-Kanade Tracking with Appearance Basis

- **Q3.3** Report the performance at frames 30, 60, 90 and 120 with the corresponding binary masks superimposed

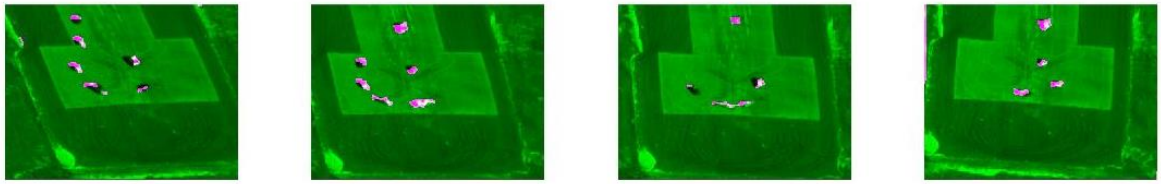

Figure 4: Moving Object Detection