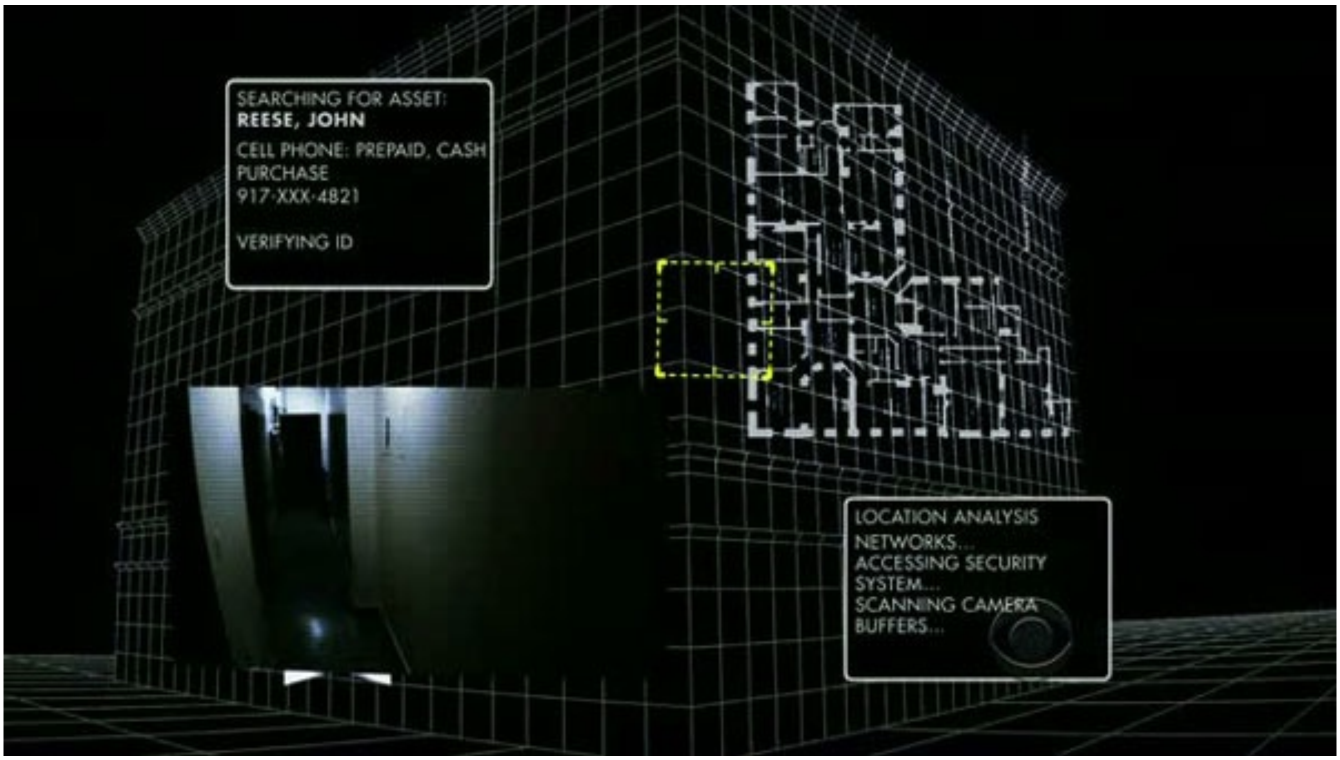
# Computer Vision

*Lucas-Kanade Motion Tracking*

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# Assignment 3

**Q1.1** $A^TA$ is given by the matrix containing the following elements

$$\begin{matrix} \sum \mathbf{Ix.Ix} & \sum \mathbf{Ix.Iy} \\ \sum \mathbf{Ix.Iy} & \sum \mathbf{Iy.Iy} \end{matrix}$$

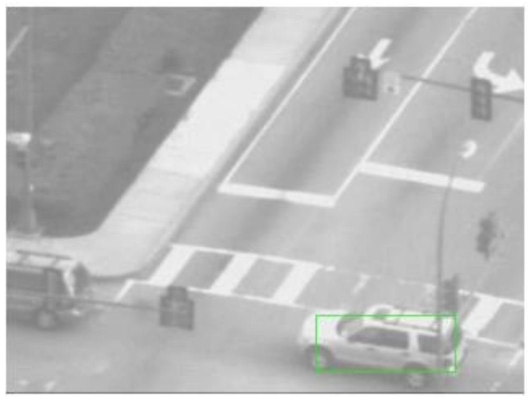
This is essentially the second moment matrix. It is similar to the Harris Corner Detector where the eigenvalues and eigenvectors are an estimate of the edge direction and magnitude.

**Q1.2** The conditions on $\mathbf{A^TA}$ in order for the offset to be reliably accurate are:

- $A^TA$ should be invertible
- Eigenvalues of $A^TA$ should not be too small
- $A^TA$ should be well conditioned.

**Q1.3** CODE: **testcarsequence.m** Output: **carseq.mat**

Shown below is the output WITHOUT template correction for frames 1, 100, 200, 300, 400.

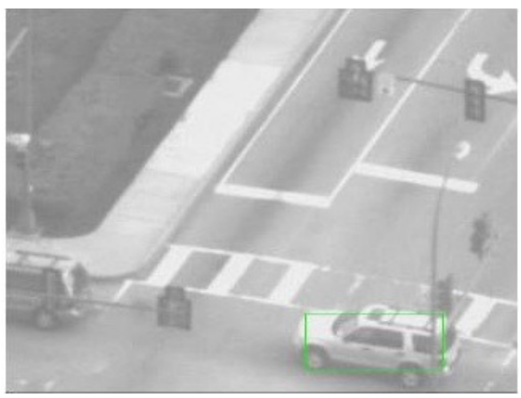




**Q1.4 EXTRA CREDIT:**

**CODE: testCarSequenceWithTemplateCorrection.m**

**Helper Function: 'LucasKanadeTemplateCorrection'**

Shown below is the output of the Lucas Kanade method with template correction that has been employed in the code. Notice how the bounding box does not drift throughout the 400 frames. The frames shown are the same as above for the sake of comparison. i.e. 1, 100, 200, 300, 400.



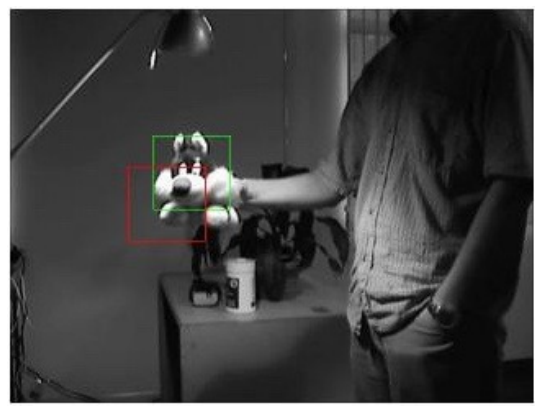
**Q2.1 Refer handwritten attachment at the end of report**

**Q2.2** CODE: **LucasKanadeBasis.m**

**Q2.3** CODE: **testSylvSequence.m;**

OUTPUT: **sylvseqrects.mat** (For original sequence) and **sylvseqextrects.mat** (For extended sequence). The red bounding box shows the output from the regular Lucas Kanade tracker and the green bounding box shows the Lucas Kanade tracker with basis vectors. It has been shown for frames 700, 800, 900, 1000 and 1100.





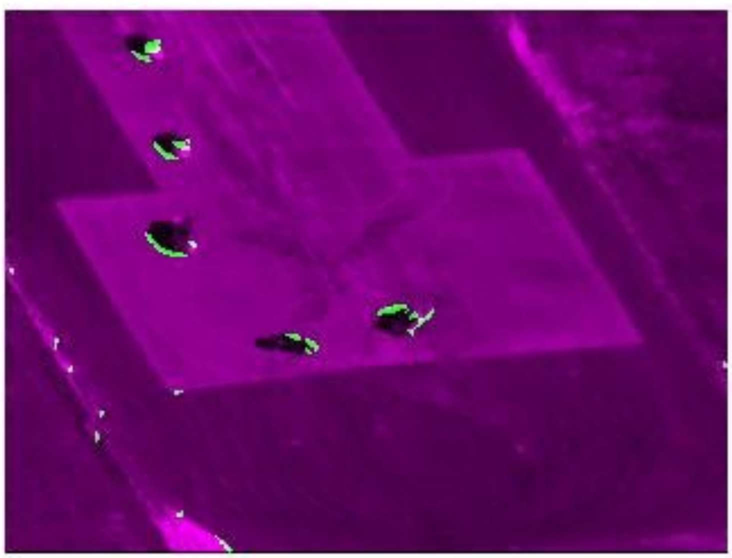

CODE: **outputsylv.m** for plotting the above rectangles.

**Q3.1** Code: **LucasKanadeAffine.m**

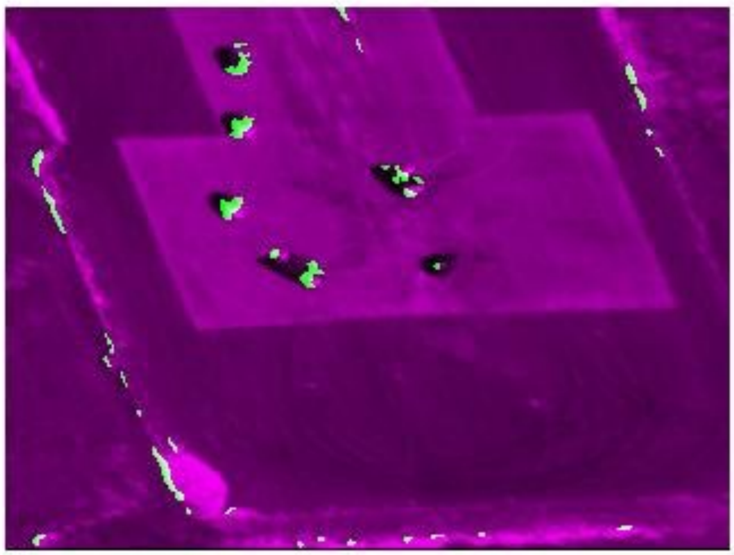
**Q3.2** Code: **SubtractDominantMotion.m**

**Q3.3** Code: **testAerialSequence.m.** The output is shown below for the frames 1, 30, 60, 90, 120. Note the green patches.

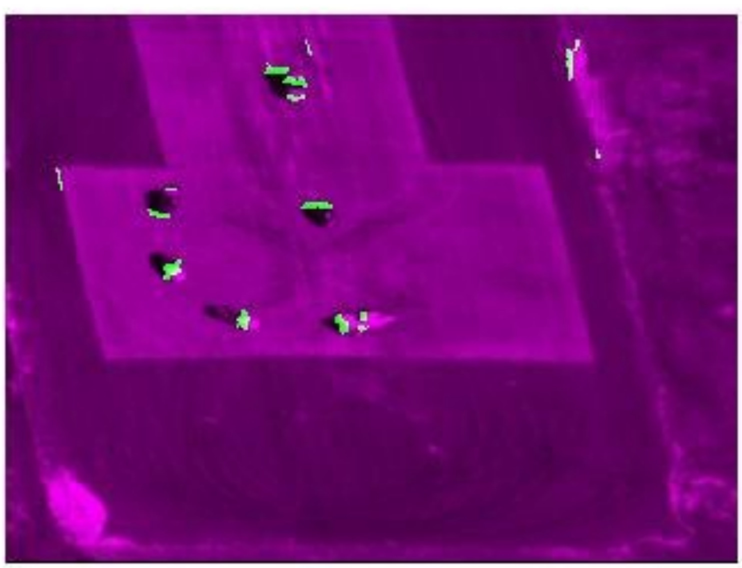
FRAME 1:



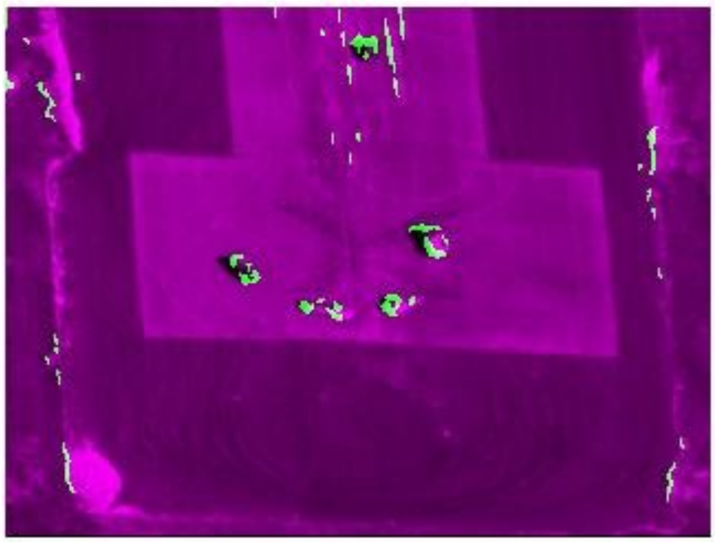
FRAME 30:



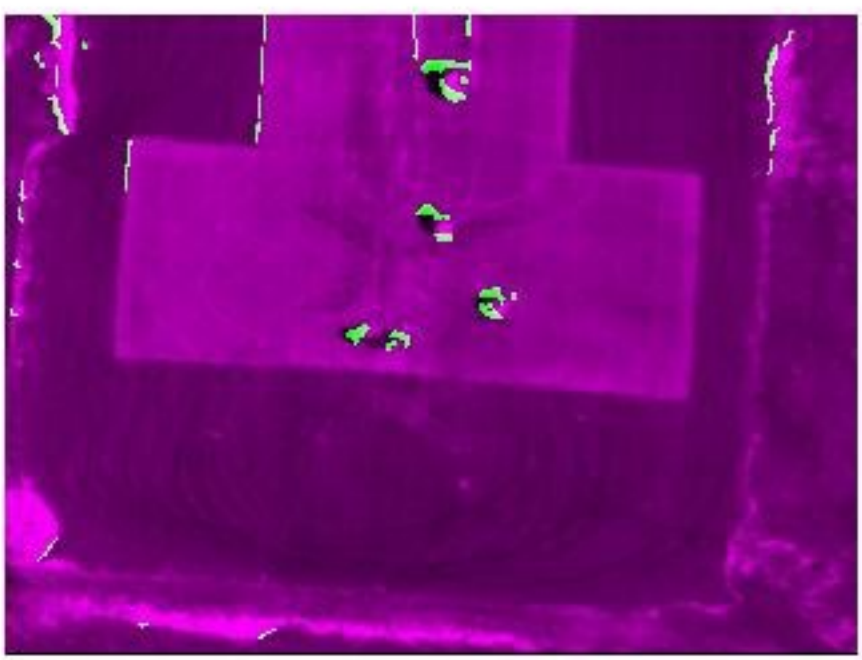
FRAME 60:



FRAME 90:



FRAME 120:



Note: I have not implemented the 'imdilate' function in these images. However, it can be implemented for better visualization of the green spots.

Q2.1 $\quad I_{t+1} = I_t + \sum w_c B_c$

Expanding, we have,

$$I_{t+1} = I_t + w_1 B_1 + w_2 B_2 + \dots w_n B_n$$

Taking dot product with $B_j$

$$(I_{t+1}) B_j = I_t B_j + \sum_{i=1}^{n} w_i B_i \cdot B_j$$

Since bases are orthogonal, the dot product $B_i \cdot B_j = |B_j|^2 \; \forall \; i = j$

$B_i \cdot B_j = 0 \; \forall \; i \neq j$

$$\Rightarrow I_{t+1} B_j = I_t B_j + w_j |B_j|^2$$

$$(I_{t+1} - I_t) B_j = w_j |B_j|^2$$

$$\boxed{w_j = \frac{(I_{t+1} - I_t)}{|B_j|^2}}$$