In this lab, you will implement optical flow algorithm in MATLAB to estimate velocities of objects in a video.

Important Note: You should complete the lab until the end of the lab hours and submit all your codes to SUCourse as a single zip file. Deadline for in-lab code submission to SUCourse is **15:30**.

Things to do:

Write a program ("lab6OFMain.m") and a function ("lab6OF.m") to calculate the optical flow throughout a video.

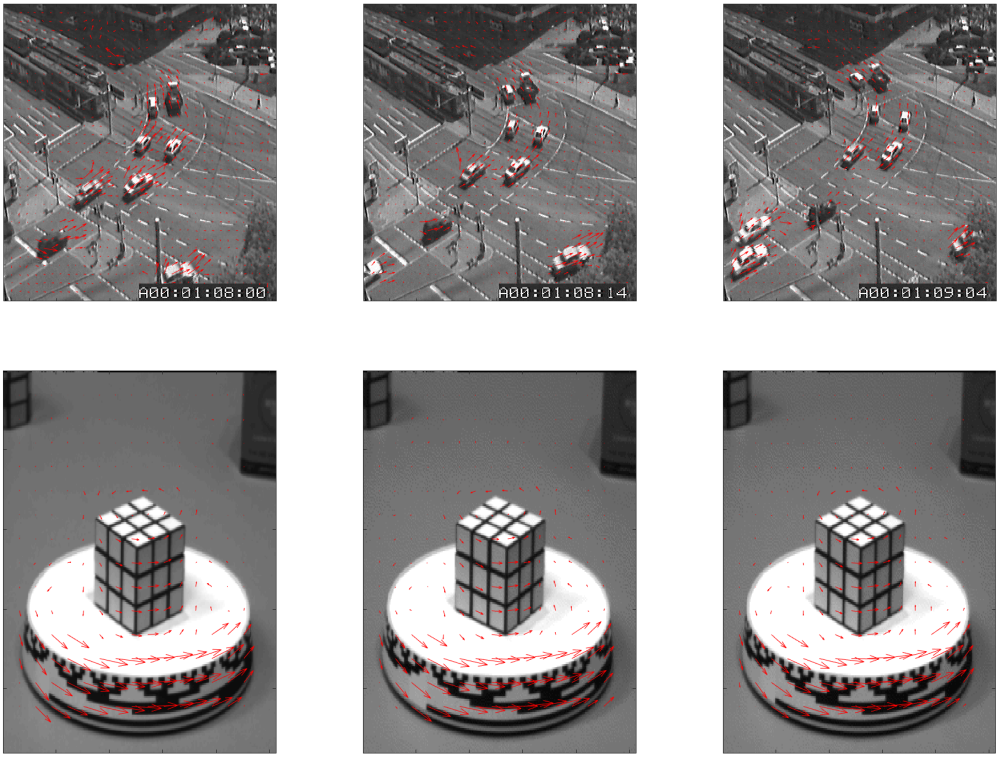
Optical flow is the distribution of the apparent velocities of objects in an image. By estimating optical flow between video frames, one can measure the velocities of objects in the video. These velocities can be estimated by computing G and b for each pixel p in a window W and solving for (u, v) as follows:

$$G = \begin{bmatrix} \sum_{p\in W} I_x^2 & \sum_{p\in W} I_x I_y \\ \sum_{p\in W} I_x I_y & \sum_{p\in W} I_y^2 \end{bmatrix} \quad b = \begin{bmatrix} \sum_{p\in W} I_x I_t \\ \sum_{p\in W} I_y I_t \end{bmatrix}$$

$$[u; v] = -G^{-1} b$$

where I_x and I_y are spatial gradients in X and Y directions, I_t is the gradient in temporal direction, u and v are velocity vectors.

Your resulting images will look as follows:



- Write the main program ("lab6OFMain.m") as follows:

```
clear all; close all; clc;
% Load the files given in SUCourse as Seq variable
[row,col,num]=size(Seq);
% Define k and Threshold
for j=2:1:num
  ImPrev = Seq(:,:,j-1)
  ImCurr = Seq(:,:,j)
  lab6OF(ImPrev,ImCurr,k,Threshold);
  pause(0.1);
end
```

- Write the function ("lab6OF.m") to calculate the optic flow of the input images as follows:

```
function lab6OF(ImPrev,ImCurr,k,Threshold)
% Smooth the input images using a Box filter
% Calculate spatial gradients (Ix, Iy) using Prewitt filter
% Calculate temporal (It) gradient
[ydim,xdim] = size(ImCurr);
u = zeros(ydim,xdim);
v = zeros(ydim,xdim);
G = zeros(2,2);
b = zeros(2,1);

cx=k+1;
for x=k+1:k:xdim-k-1
  cy=k+1;
  for y=k+1:k:ydim-k-1
  % Calculate the elements of G and b
    if (min(eigenvalues of G) < Threshold)
      u(cy,cx)=0;
      v(cy,cx)=0;
    else
      % Calculate (u,v)
      u(cy,cx)=OF(1);
      v(cy,cx)=OF(2);
    end
    cy=cy+k;
  end
  cx=cx+k;
end
cla reset;
imagesc(ImPrev); hold on;
[xramp,yramp] = meshgrid(1:1:xdim,1:1:ydim);
quiver(xramp,yramp,u,v,10,'r');
colormap gray;
end
```

Post Lab

Provide resulting images for each step. Explain the procedure that you follow. Compare the performances of optical flow algorithm with different window sizes ($k = 5$, $k = 10$, $k = 15$) and smoothing filters (Box and Gaussian). Discuss and comment on your results.

Deadline for post lab report submission to SUCourse: **05 December 2022, 23:55**.