**ASSIGNMENT A10**

Shantnu Kakkar

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**Section 1: Intro:**

This assignment is based on the tracking method learnt in the lecture. I will be using two method: Background subtraction and Kalman filter.

For this problem, we are given two image sequences (one with ball and one with bead) and we need to track them. After the implementation, I will be answering the following question:

* How does the results of Kalman filter method change with change in Covariance matrix for process and observations?
* What is the estimated gravitational constant?

**Section 2: Method:**

* Matlab is used to carry out the experiments.
* Following are my methods for functions:
* CS5320\_background\_sub\_tracking(im)
  + Initalize everything [nr,nc,nd] = size(im(1).im);

NumOfImages = numel(im);

t\_im = zeros(nr,nc,nd);

sum\_im = zeros(nr,nc,nd);

mean\_im = zeros(nr,nc,nd);

* + for i = 1:NumOfImages
  + sum\_im = double(im(i).im) + sum\_im;
  + end
  + mean\_im = sum\_im/NumOfImages;
  + for p = 1:NumOfImages
  + RedDifference = double(im(p).im(:,:,1)) - mean\_im(:,:,1);
  + GreenDifference = double(im(p).im(:,:,2)) - mean\_im(:,:,2);
  + BlueDifference = double(im(p).im(:,:,3)) - mean\_im(:,:,3);
  + for r = 1:nr
  + for c = 1:nc
  + t\_im(r,c,p) = norm([RedDifference(r,c),GreenDifference(r,c),BlueDifference(r,c)]);
  + end
  + end
  + % t\_im(:,:,i) = norm
  + End
* CS5320\_const\_acc(x0,y0,vx0,vy0,ax0,ay0,del\_t,max\_t,R)

trace = [x0,y0,vx0,vy0,ax0,ay0];

* + CurrentState = [x0,y0,vx0,vy0,ax0,ay0];
  + times = [0:del\_t:max\_t];
  + num\_steps = length(times)-1;
  + num\_locs = length(CurrentState);
  + D= [1,0,del\_t,0,0,0;...
  + 0,1,0,del\_t,0,0;
  + 0,0,1,0,del\_t,0;
  + 0,0,0,1,0,del\_t;
  + 0,0,0,0,1,0;
  + 0,0,0,0,0,1];
  + for i = 1:num\_steps
  + CurrentState = CS5320\_process\_step(CurrentState',D,R);
  + CurrentState = CurrentState';
  + trace = [trace;CurrentState]
  + End
* CS5320\_const\_vel(x0,y0,vx0,vy0,del\_t,max\_t,R)
  + trace = [x0,y0,vx0,vy0];
  + CurrentState = [x0,y0,vx0,vy0];
  + times = [0:del\_t:max\_t];
  + num\_steps = length(times)-1;
  + num\_locs = length(CurrentState);
  + Di = [1,0,del\_t,0;...
  + 0,1,0,del\_t;
  + 0,0,1,0;
  + 0,0,0,1];
  + for i = 1:num\_steps
  + CurrentState = CS5320\_process\_step(CurrentState',D,R);
  + CurrentState = CurrentState';
  + trace = [trace;CurrentState];
  + end
* CS5320\_detect\_red\_ball(im,model)
  + [nr,nc,nd] = size(im);
  + temp\_im = zeros(nr,nc);
  + for r = 1:nr
  + for c = 1:nc
  + if im(r,c,1) > model(1) & im(r,c,2) < model(2) & im(r,c,3) < model(3)
  + temp\_im(r,c) = 1;
  + end
  + end
  + end
  + [row,col] = find(temp\_im==1);
  + row = floor(mean(row));
  + col = floor(mean(col));
* CS5320\_Kalman\_step(x\_im1,Sigma\_im1, D,R,M,Q,y)
  + x\_i\_minus = D\*x\_im1;
  + sigma\_i\_minus = R + D\*Sigma\_im1\*D';
  + K = sigma\_i\_minus\*(M')\*inv(M\*sigma\_i\_minus\*(M') + Q);
  + x\_i\_plus = x\_i\_minus + K\*(y - M\*x\_i\_minus);
  + Sigma\_i\_plus = sigma\_i\_minus - K\*M\*sigma\_i\_minus;
* CS5320\_observe(x,M,Q)
  + y = M\*x + mvnrnd([0;0],Q)';
* CS5320\_process\_step
  + p\_i = D\*p\_im1 + mvnrnd(zeros(size(p\_im1)),R)';
* CS5320\_const\_acc\_Kalman
  + x = [x0,y0,vx0,vy0,ax0,ay0]';
  + Sigma = zeros(length(x));
  + ta = x';
  + ty = [];
  + te = x';
  + M = [1 0 0 0 0 0;...
  + 0 1 0 0 0 0];
  + D= [1,0,del\_t,0,0,0;...
  + 0,1,0,del\_t,0,0;
  + 0,0,1,0,del\_t,0;
  + 0,0,0,1,0,del\_t;
  + 0,0,0,0,1,0;
  + 0,0,0,0,0,1];
  + for i = 1:del\_t:max\_t
  + x = CS5320\_process\_step(x,D,R);
  + ta = [ta;x'];
  + y = CS5320\_observe(x,M,Q);
  + ty = [ty;y'];
  + [x,Sigma] = CS5320\_Kalman\_step(x,Sigma,...
  + D,R,M,Q,y);
  + te = [te;x']
  + end

**Section 3: Verification:**

* **Testing CS5320\_background\_sub\_tracking**
  + - **On comparing with a threshold, I am getting bead at the right location**

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