Danion and Flanagan 2018 - Different gaze strategies during eye versus hand tracking of a moving target

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```
clear; clc;
cd('/Users/duncan/OneDrive - University of Delaware - o365/Documents
```

Target motion

Combination of two sinusoids along both x and y dimensions.

$$x_t = A_{1x}\cos\omega t + A_{2x}\cos(h_x\omega\, t - \varphi_x)$$

$$y_t = A_{1y}\cos\omega t + A_{2y}\cos(h_y\omega\, t - \varphi_y)$$

```
% annomyous function
combSins = @(x) x(1) * cosd(x(2)*x(3)) + x(4) * cosd(x(5) * x(2) * x

% ICs
A1x = [5,4,4,5,5.1]; % cm
A2x = [5,5,5.1,5,5.2]; % cm
Hx = [2,2,3,3,2]; % harmonic x
Px = [45, -60, -60, 90, -90]; % Phase x
A1y = [5,3,4,3.4,4]; % cm
A2y = [5,5,5.2,5,5]; % cm
Hy = [3,3,2,2,3]; % harmonic y
Py = [-135, -135, -135, 45, 22.5]; % Phase y
time = 1:1:10000; % time
omega = 0.073; % Hz (fundamental)
% guestimated results  'experiment_outcome_stat'
ET_et_cm_mu = 1;
ET_et_cm_sigma = 0.2;
HT_et_cm_mu = 0.98;
HT_et_cm_sigma = 0.1;
ET_et_ms_mu = 26;
ET_et_ms_sigma = 2;
```

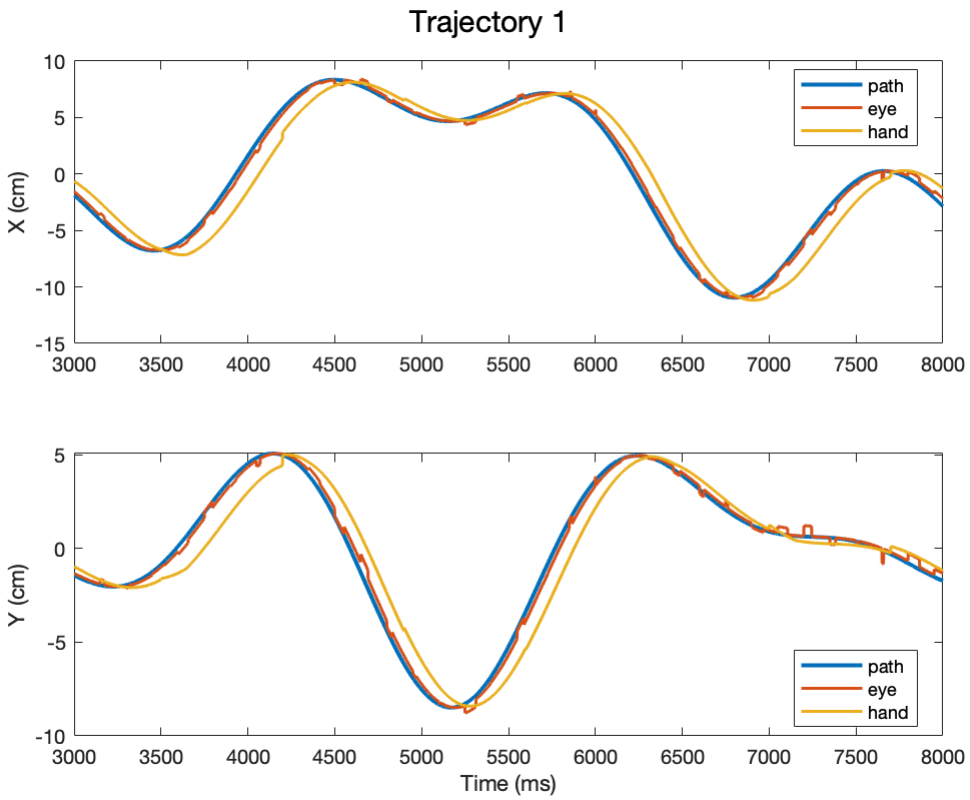
```
HT_et_ms_mu = 35;
HT_et_ms_sigma = 2;
ET_sps = 2.76; % saccade per second
HT_sps = 2.06;
hand_cm_mu = 0;
hand_cm_sigma = 0.4;
hand_ms_mu = 108;
hand_ms_sigma = 8;
new_hand_noise = false;
ii = 0;

xt = nan([length(time), length(Py)]);
yt = nan([length(time), length(Py)]);
xy = nan([length(time), length(Py), 2, 3]); % time, trajectory numbe
% Calculate
filenames = strings([length(Py), 1]);
for i = 1:length(Py) % number of trajectories
    filenames{i} = sprintf('trajectory%d', i);
    for t = 1:length(time)
        xt(t,i) = combSins([A1x(i), omega, t, A2x(i), Hx(i), Px(i)])
        yt(t,i) = combSins([A1y(i), omega, t, A2y(i), Hy(i), Py(i)])
        xy(t,i,:,1) = rotateByDeg(xt(t,i), yt(t,i), 60); % rotate to
        if t <= ET_et_ms_mu+5  % starting off
            eye_delay = 0;
            eye_noise = 0;
        else
            eye_delay = ET_et_ms_mu;
            if rem(t,150) == 0 % new noise
                eye_noise = normrnd(0,0.3);
            elseif rem(t,ET_sps) < 0.01 % catch up saccade
                eye_noise = 0;
            end
        end
        if t <= hand_ms_mu +5 % starting off
            hand_delay = 0;
            hand_noise = 0;
        else
            hand_delay = hand_ms_mu;
            if rem(t,700) == 0 % new noise
                hand_noise_total = linspace(0, normrnd(0,0.4), 150);
                new_hand_noise = true;
```

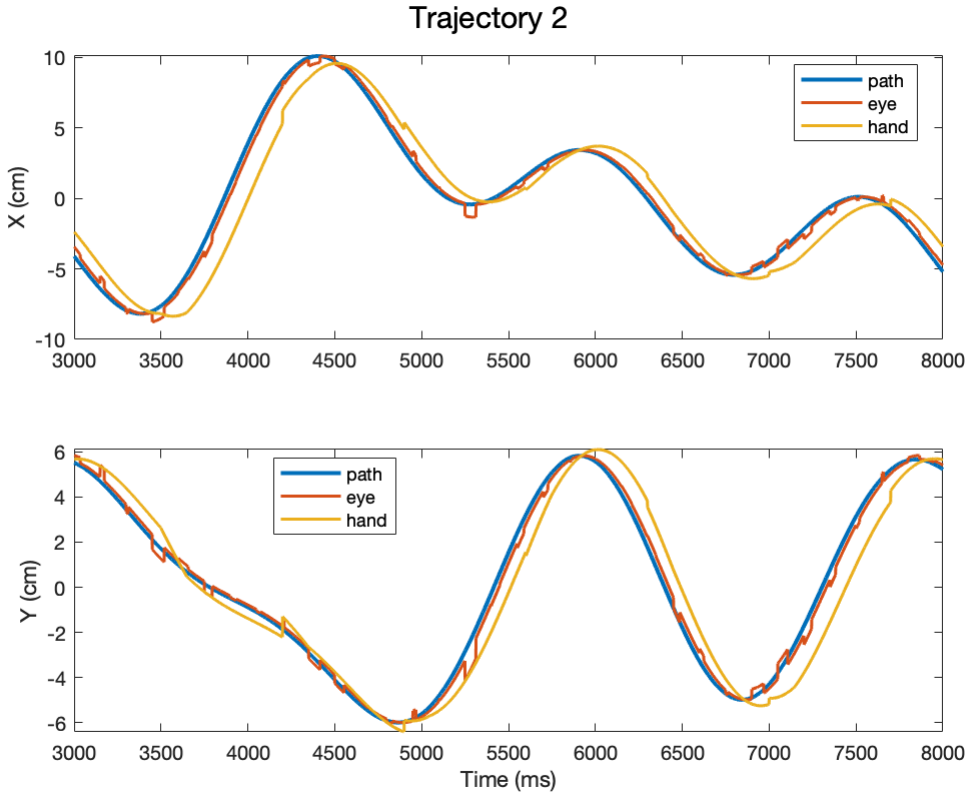
```
                ii = 1;
            end
            if ii == 150
                new_hand_noise = false;
            elseif new_hand_noise
                hand_noise = hand_noise_total(ii);
                ii = ii+1;
            end
        end
        xy(t,i,:,2) = xy(t-eye_delay,i,:,1) + eye_noise; % eye
        xy(t,i,:,3) = xy(t-hand_delay,i,:,1) + hand_noise; % hand
    end
end
```

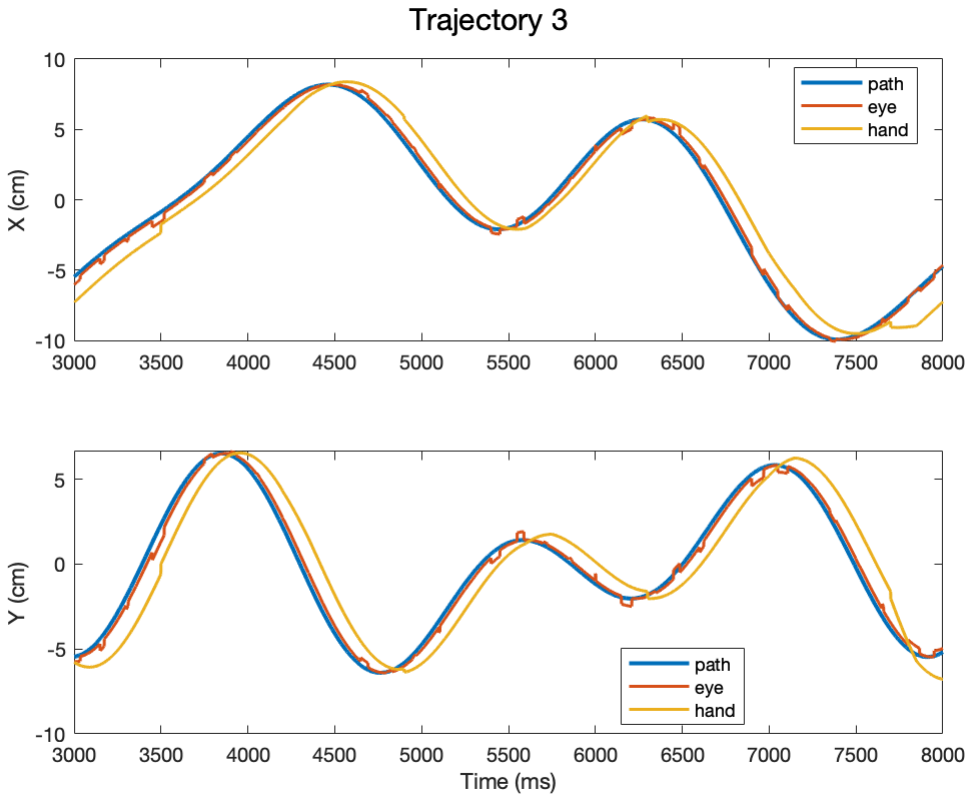
Figure 4

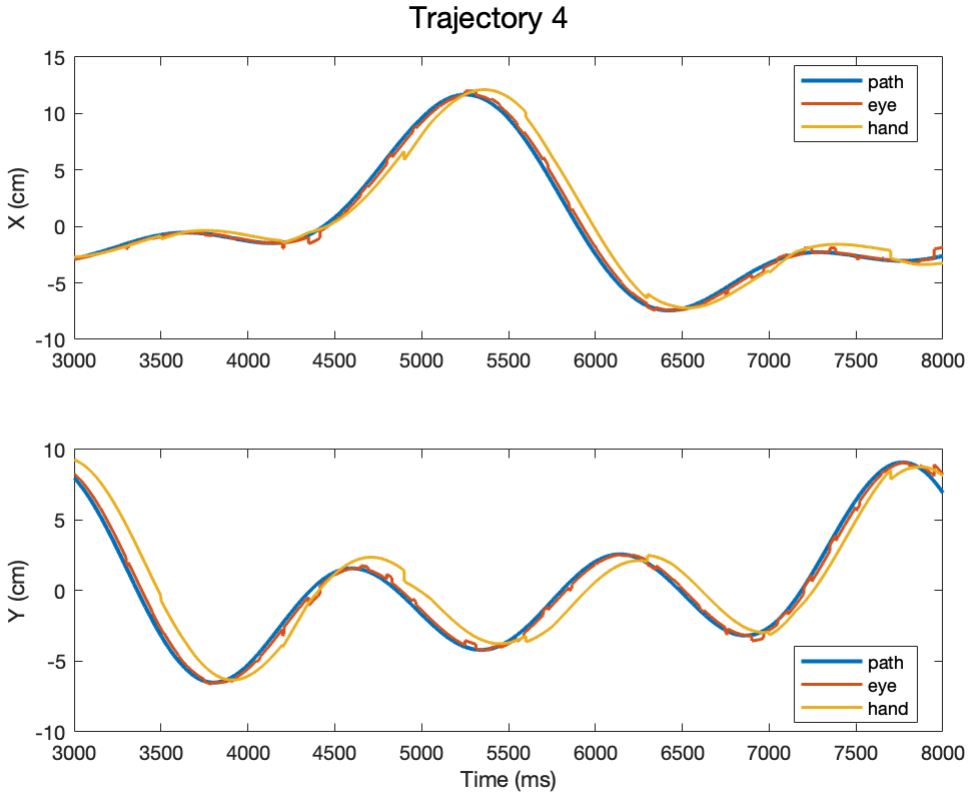
Replicate figure 4 to test if shapes are right

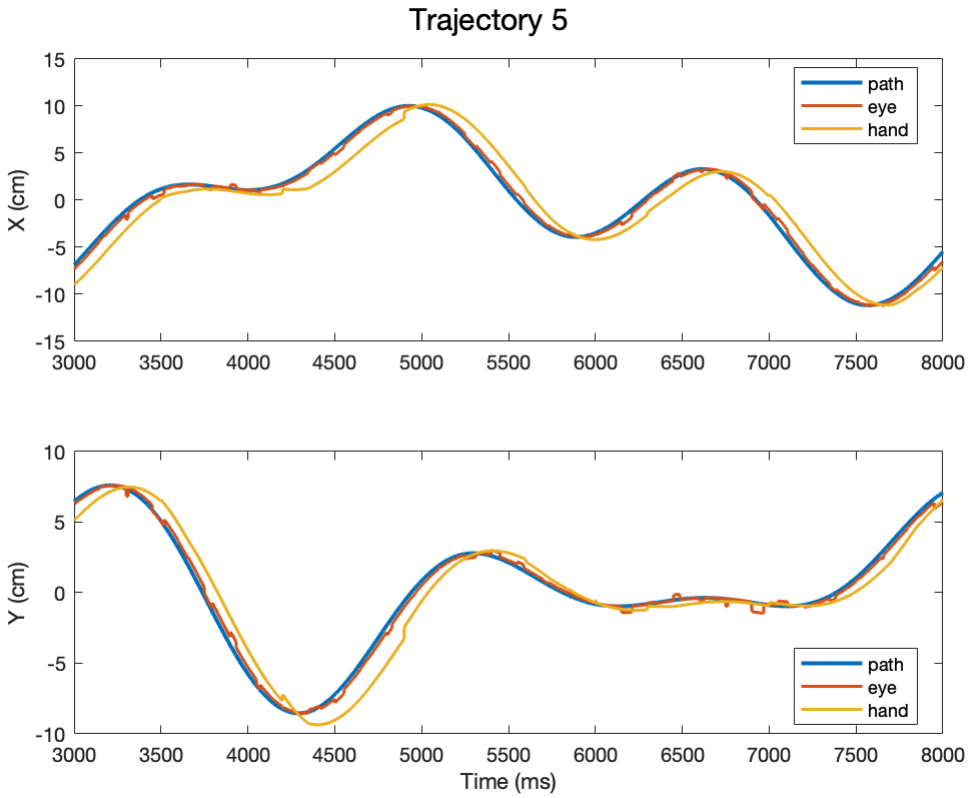
```
% IC
log_idx = time>3000 & time <= 8000;
% each trajectory
for i = 1:length(Py)
    figure;
    subplot(2,1,1);
    plot(time(log_idx), xy(log_idx,i,1,1), 'linewidth', 2); % trajec
    hold on
    plot(time(log_idx), xy(log_idx,i,1,2), 'linewidth', 1.5); % eye
    plot(time(log_idx), xy(log_idx,i,1,3), 'linewidth', 1.5); % hand
    legend('path', 'eye', 'hand', 'location', 'best')
    ylabel('X (cm)')
    subplot(2,1,2);
    plot(time(log_idx), xy(log_idx,i,2,1), 'linewidth', 2); % trajec
    hold on
    plot(time(log_idx), xy(log_idx,i,2,2), 'linewidth', 1.5); % eye
    plot(time(log_idx), xy(log_idx,i,2,3), 'linewidth', 1.5); % hand
    legend('path', 'eye', 'hand', 'location', 'best')
    ylabel('Y (cm)')
    sgtitle(sprintf('Trajectory %d', i))
    SP_labels('x', 'Time (ms)')
end
```


Trajectory 1
X (cm)
Y (cm)
Time (ms)
path
eye
hand


Trajectory 2
X (cm)
Y (cm)
Time (ms)
path
eye
hand


Trajectory 3
X (cm)
Y (cm)
Time (ms)
path
eye
hand


Trajectory 4
X (cm)
Y (cm)
Time (ms)
path
eye
hand



Behavior

```
% visualize
for i = 1:length(Py)
    for type = 1:2
        if type == 1
            exp = 'eye-track';
        elseif type == 2
            exp = 'hand-track';
        end
        figure;
        plot(xy(:,i,1,1), xy(:,i,2,1), '-', 'linewidth', 2, 'color',
        hold on
        dot = plot(xy(1,i,1,1), xy(1,i,2,1), 'mo', 'markersize', 10,
        eye = plot(xy(1,i,1,2), xy(1,i,2,2), 'g+', 'markersize', 7,
        if type == 2
            hand = plot(xy(1,i,1,3), xy(1,i,2,3), 'ro', 'markersize'
        end
        xlabel('x (cm)'); ylabel('y (cm)');
        title(sprintf('Trajectory %d', i))
        set(gcf, 'visible', 'on');
        axis manual
```

```
        kBackground(gca);

        writeGif(append(filenames{i}, '_', exp, '.gif'), 1, 0.001)

        for t = 2:60:10000 % 2:length(time)
            set(dot, 'XData', xy(t,i,1,1));
            set(dot, 'YData', xy(t,i,2,1));
            set(eye, 'XData', xy(t,i,1,2));
            set(eye, 'YData', xy(t,i,2,2));
            if type == 2
                set(hand, 'XData', xy(t,i,1,3));
                set(hand, 'YData', xy(t,i,2,3));
            end
%             pause(0.001)
            writeGif(append(filenames{i}, '_', exp, '.gif'), t, 0.00
        end
        close(gcf)
    end
end
```

```
function xy = rotateByDeg(x,y,deg)
rotationMatrix = [cosd(deg), sind(deg); -sind(deg), cosd(deg)];
xy = rotationMatrix * [x;y];
end
```