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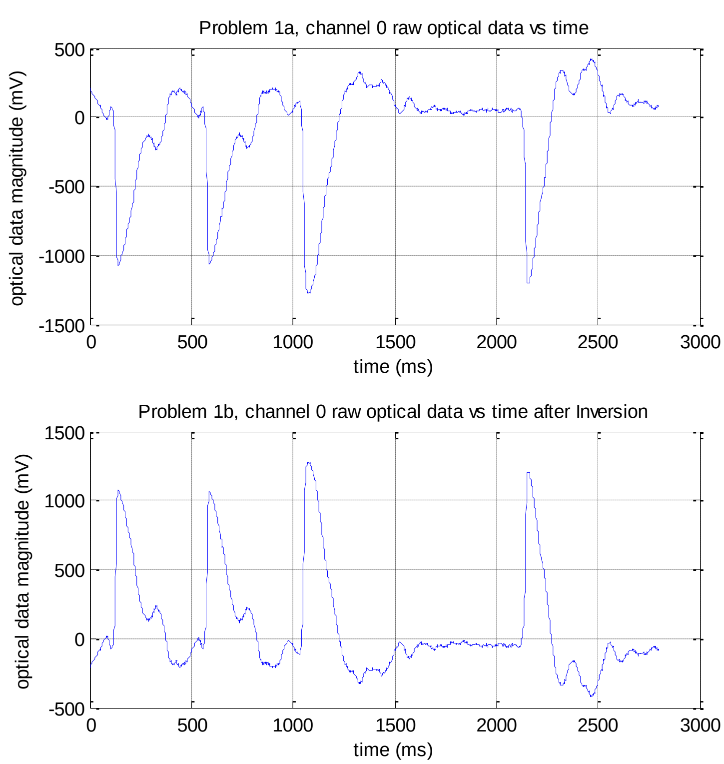
Imaging – Rabbit Optical Mapping

Loading Data:

```
clear all; close all; clc;

opticalDataFile = fopen('002.log','r','b');
data = fread(opticalDataFile,[264,inf],'int16');
```

Plotting Data: Magnitude vs. Time

```
%PART 1A:
time = 1:length(data);

figure;
subplot(2,1,1);
plot(time,data(1,:));
grid;  title('Problem 1a, channel 0 raw optical data vs time');
xlabel('time (ms)'); ylabel('optical data magnitude (mV)');

%Part 1b:  Invert
data2 = -1.*data;
subplot(2,1,2);% figure;
plot(time,data2(1,:)); grid;
title('Problem 1b, channel 0 raw optical data vs time after Inversion');
xlabel('time (ms)'); ylabel('optical data magnitude (mV)');
```



The upper graph in the figure to the left shows the raw optical data from channel 0 vs. time. This is before any transformation. The lower graph shows the same raw optical data from channel 0 vs. time, but now it has been inverted to more closely resemble the data from the PDA main. The data in PDA main was exactly the same as the originally plotted data, but it was inverted by comparison. Inverting the channel 0 data made the 2 match.

Calculating Activation Times of the Action Potentials:

When finding times associated with given magnitudes, it is important to note those magnitudes are relative to baseline of the AP. Given that there were 256 channels, and that each had dramatically different non zero baselines, a choice was made to use a simple method of determining baseline. Doing each channel individually would have been unreasonable, and since each waveform differed, there was no clear calculation. Instead a trend was noticed. By eye, the mean baseline of the average channel was around the initial value at time 0. This was not 100% accurate, and the accuracy varies by channel, however by some personal testing, it proved better than using just 0 as a baseline.

```
%Problem 2.%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
single_AP_data = data2(1:256,1:500);
t_1_ap = 1:length(single_AP_data);

[r,c] = size(single_AP_data);
dv_dt = zeros(r,c-1);
for i = 1:256
    dv_dt(i,:) = diff(single_AP_data(i,:))./diff(t_1_ap);
end

max_dvdt_and_index = zeros(256,2);
for i = 1:256
[max_dvdt_and_index(i,1) max_dvdt_and_index(i,2)] = max(dv_dt(i,:));
end

activation_times = zeros(16,16);
for i=0:15
    for j =1:16
        activation_times(i+1,j) = max_dvdt_and_index((i*16)+j,2);
    end
end
display(activation_times);
```

Activation Times

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	128	129	130	132	132	133	137	137	138	134	135	130	132	133	133	132
2	128	129	128	130	131	132	136	134	133	133	132	131	131	131	133	122
3	127	127	128	130	130	132	132	135	133	133	132	132	132	132	133	129
4	125	125	127	128	129	131	132	133	135	133	133	132	131	132	131	132
5	125	124	127	126	127	129	130	132	132	132	132	132	132	129	128	131
6	123	124	125	125	126	128	129	130	131	131	133	133	131	129	129	122
7	121	121	125	125	126	126	127	130	131	132	133	133	130	130	130	130
8	120	119	124	122	125	125	126	128	130	132	132	133	130	130	129	126
9	119	121	121	123	123	124	125	126	128	130	132	133	129	129	128	128
10	121	121	121	122	120	124	124	125	126	129	131	132	131	129	127	128
11	121	120	121	120	120	124	122	123	124	127	130	131	132	129	126	127
12	120	120	120	121	119	122	123	123	123	126	128	130	131	130	127	127
13	120	119	119	119	118	121	122	121	123	127	128	131	131	128	124	127
14	116	119	118	119	118	120	121	120	121	123	127	130	131	128	124	126
15	119	119	118	118	118	119	120	121	122	123	126	127	129	125	127	126
16	117	118	118	116	118	118	119	121	119	121	124	127	127	124	125	123

Calculating Repolarization Times of the Action Potentials:

```
%Problem 3%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
repolarization_vector = zeros(1,256);
for i = 1:256
    channel_target_value = single_AP_data(i,1)+0.1*(max(single_AP_data(i,:)) -
single_AP_data(i,1));
    index = find(single_AP_data(i,:) > channel_target_value,1,'last');
    repolarization_vector(i) = index;
end

repolarization_times = zeros(16,16);
for i=0:15
    for j =1:16
        repolarization_times(i+1,j) = repolarization_vector((i*16)+j);
    end
end
display(repolarization_times);
```

Repolarization Times

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	382	393	393	395	395	396	397	397	398	394	393	394	396	392	389	390
2	387	391	393	395	395	395	396	395	396	394	394	392	396	394	390	390
3	393	388	388	393	394	394	396	394	394	394	392	392	393	394	392	390
4	391	390	390	391	394	394	395	396	394	393	394	392	392	394	395	389
5	387	389	388	390	390	393	394	395	395	394	393	391	392	392	393	392
6	387	387	389	389	390	392	393	393	395	392	392	392	391	392	389	392
7	387	386	386	390	390	392	390	392	395	393	392	393	392	391	391	392
8	387	387	386	388	388	391	390	390	393	394	392	391	392	390	389	388
9	386	387	387	386	387	390	389	391	390	392	391	392	387	389	390	388
10	386	387	386	387	387	387	389	390	390	391	393	390	390	386	389	389
11	385	385	387	386	388	388	388	389	391	390	391	390	390	387	388	390
12	385	385	386	387	387	385	387	388	390	390	388	390	388	384	386	387
13	385	385	385	385	386	385	385	386	390	389	384	386	388	385	384	382
14	383	385	385	385	384	385	386	387	387	388	387	388	390	382	377	500
15	382	384	384	384	384	384	386	386	388	390	387	387	384	379	500	384
16	381	382	384	383	384	385	384	386	388	388	389	389	385	375	385	383

Calculating ADP90 Values:

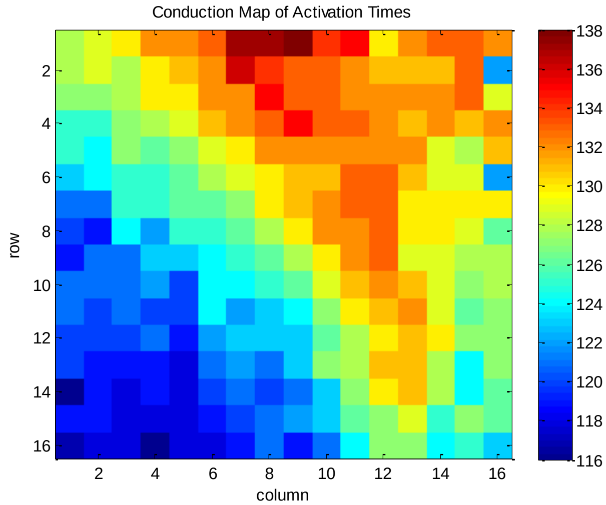
```
%Problem 4:
APD_90_values = 0.9.*repolarization_times-activation_times;
display(APD_90_values);
```

APD90 Values

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	215.80	224.70	223.70	223.50	223.50	223.40	220.30	220.30	220.20	220.60	218.70	224.60	224.40	219.80	217.10	219.00
2	220.30	222.90	225.70	225.50	224.50	223.50	220.40	221.50	223.40	221.60	222.60	221.80	225.40	223.60	218.00	229.00
3	226.70	222.20	221.20	223.70	224.60	222.60	224.40	219.60	221.60	221.60	220.80	220.80	221.70	222.60	219.80	222.00
4	226.90	226.00	224.00	223.90	225.60	223.60	223.50	223.40	219.60	220.70	221.60	220.80	221.80	222.60	224.50	218.10
5	223.30	226.10	222.20	225.00	224.00	224.70	224.60	223.50	223.50	222.60	221.70	219.90	220.80	223.80	225.70	221.80
6	225.30	224.30	225.10	225.10	225.00	224.80	224.70	223.70	224.50	221.80	219.80	219.80	220.90	223.80	221.10	230.80
7	227.30	226.40	222.40	226.00	225.00	226.80	224.00	222.80	224.50	221.70	219.80	220.70	222.80	221.90	221.90	222.80
8	228.30	229.30	223.40	227.20	224.20	226.90	225.00	223.00	223.70	222.60	220.80	218.90	222.80	221.00	221.10	223.20
9	228.40	227.30	227.30	224.40	225.30	227.00	225.10	225.90	223.00	222.80	219.90	219.80	219.30	221.10	223.00	221.20
10	226.40	227.30	226.40	226.30	228.30	224.30	226.10	226.00	225.00	222.90	222.70	219.00	220.00	218.40	223.10	222.10
11	225.50	226.50	227.30	227.40	229.20	225.20	227.20	227.10	227.90	224.00	221.90	220.00	219.00	219.30	223.20	224.00
12	226.50	226.50	227.40	227.30	229.30	224.50	225.30	226.20	228.00	225.00	221.20	221.00	218.20	215.60	220.40	221.30
13	226.50	227.50	227.50	227.50	229.40	225.50	224.50	226.40	228.00	223.10	217.60	216.40	218.20	218.50	221.60	216.80
14	228.70	227.50	228.50	227.50	227.60	226.50	226.40	228.30	227.30	226.20	221.30	219.20	220.00	215.80	215.30	324.00
15	224.80	226.60	227.60	227.60	227.60	226.60	227.40	226.40	227.20	228.00	222.30	221.30	216.60	216.10	323.00	219.60
16	225.90	225.80	227.60	228.70	227.60	228.50	226.60	226.40	230.20	228.20	226.10	223.10	219.50	213.50	221.50	221.70

Creating a Conduction Map Based on Activation Times:

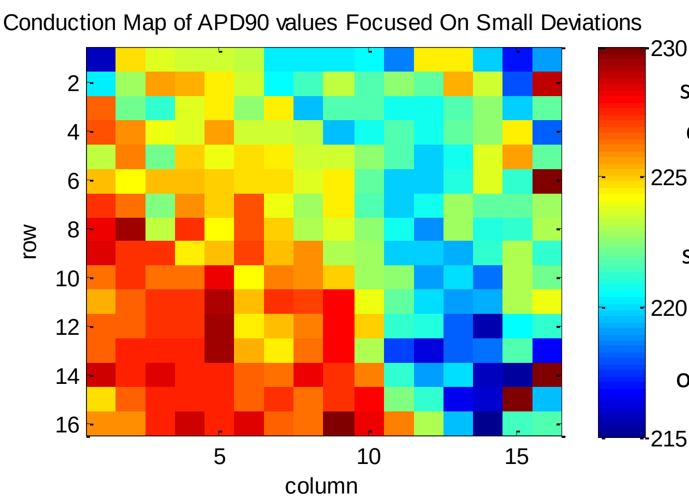
```
%Problem 5:

figure;
imagesc(activation_times); colorbar;
title('Conduction Map of Activation Times');
xlabel('column');
ylabel('row');
```



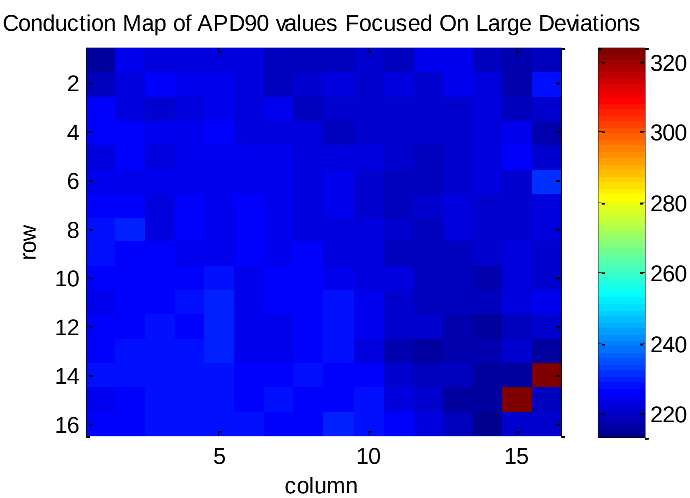
Since the activation times are larger (meaning the activation occurs later in time) towards the top middle, and shortest in the bottom left, the conduction is moving diagonally to the top middle from the bottom left. From the dark blue toward the dark red.

Creating a Conduction Map of the ADP90 Times:

```
%Problem 6:
figure; subplot(2,1,1);
imagesc(APD_90_values); colorbar;
title('Conduction Map of APD90 values Focused On Small Deviations');
xlabel('column');ylabel('row'); caxis([215,230]);

subplot(2,1,2);
imagesc(APD_90_values); colorbar;
title('Conduction Map of APD90 values Focused On Large Deviations');
xlabel('column');ylabel('row');
```



The conduction map of APD90 values was so swayed by two extremely different channels, that differentiation between any 2 of the majority of channels was difficult to see. For this reason, a conduction map with a smaller range for colors is shown in the upper part of the figure on the left, and a conduction map in the lower part of the figure with a full range for colors clearly shows the two outlying channels. Those channels are channels 224 and 229.



Motion artifacts occur in channels 224 and 229 in the APD90 Map. The data in these channels shows why. To demonstrate how they differ from the useful channel recordings, each of the artifact containing channels has been shown in-between its nearest neighbors below. Both have an almost iso-electric waveform, meaning the area under the upward curve almost equals the area above the downward curve. Unfortunately this taints the ability to discern proper activation and repolarization times used to calculate APD90 values. These 2 channels are corrupted by motion artifacts.