

$$l = \frac{a_0 + a_1 X + a_2 Y}{C_1 X + C_2 Y + 1}$$

$$s = \frac{b_0 + b_1 X + b_2 Y}{C_1 X + C_2 Y + 1}$$

$$l C_1 X + l C_2 Y + l = a_0 + a_1 X + a_2 Y$$

$$s C_1 X + s C_2 Y + s = b_0 + b_1 X + b_2 Y$$

$$l = a_0 + a_1 X + a_2 Y - l C_1 X - l C_2 Y$$

$$s = b_0 + b_1 X + b_2 Y - s C_1 X - s C_2 Y$$

pseudo linear model LS model =

$$V_l - a_0 - a_1 X - a_2 Y - l C_1 X - l C_2 Y = -l$$

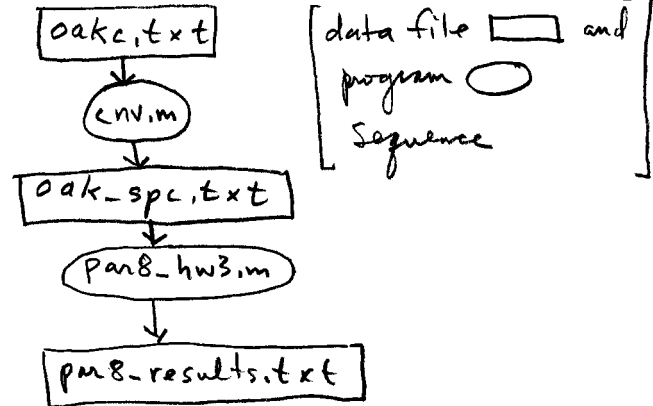
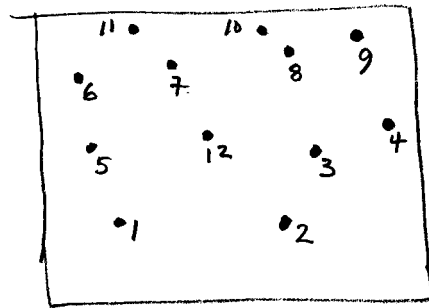
$$V_s - b_0 - b_1 X - b_2 Y - s C_1 X - s C_2 Y = -s$$

condition equations =

$$\begin{matrix} * \\ \begin{matrix} V_{l_1} \\ V_{s_1} \\ V_{l_2} \\ V_{s_2} \\ \vdots \\ V_{l_{12}} \\ V_{s_{12}} \end{matrix} \end{matrix} + \begin{matrix} \begin{bmatrix} -1 & -X_1 & -Y_1 & 0 & 0 & 0 & -l_1 X_1 & -l_1 Y_1 \\ 0 & 0 & 0 & -1 & -X_1 & -Y_1 & -s_1 X_1 & -s_1 Y_1 \\ -1 & -X_2 & -Y_2 & 0 & 0 & 0 & -l_2 X_2 & -l_2 Y_2 \\ 0 & 0 & 0 & -1 & -X_2 & -Y_2 & -s_2 X_2 & -s_2 Y_2 \\ \vdots & & & & & & & \\ -1 & -X_{12} & -Y_{12} & 0 & 0 & 0 & -l_{12} X_{12} & -l_{12} Y_{12} \\ 0 & 0 & 0 & -1 & -X_{12} & -Y_{12} & -s_{12} X_{12} & -s_{12} Y_{12} \end{bmatrix} \\ \mathbf{B} \\ (24, 8) \end{matrix} \cdot \begin{matrix} \begin{bmatrix} a_0 \\ a_1 \\ a_2 \\ b_0 \\ b_1 \\ b_2 \\ C_1 \\ C_2 \end{bmatrix} \\ \mathbf{\Delta} \\ (8, 1) \end{matrix} = \begin{matrix} \begin{bmatrix} -l_1 \\ -s_1 \\ -l_2 \\ -s_2 \\ \vdots \\ -l_{12} \\ -s_{12} \end{bmatrix} \\ \mathbf{f} \\ (24, 1) \end{matrix}$$

$$\Delta = (B^T B)^{-1} B^T f \quad \text{assume } W = I_{24}$$

$$V = f - B \Delta$$



* note: X_i, Y_i should be shifted to local origin

$$\begin{aligned}
 X_i &= X_i(\text{original}) - X_{\text{ref}} \\
 Y_i &= Y_i(\text{original}) - Y_{\text{ref}}
 \end{aligned}$$

```
par8_hw3
Xmean = 564170
Ymean = 4184596
size of array X
m = 12
n = 1
v =
-0.609316361142646
-0.733309163325487
-0.335375286184558
 1.88574855124193
-1.26231390831072
-1.71857502362604
-0.951143398074862
 0.137817683510434
 0.274385194617821
-0.15975099455855
 1.11091698084894
 1.1374353471481
-0.582942659251188
-0.962419707079363
 0.2723205923877
-1.44094181243304
 1.26687076103724
 0.931136096079626
 0.341828411441917
 0.234492429255624
-1.8243755928095
 0.424726237956776
 2.29914526544007
 0.2636403558285
```

residuals in pixels, l/s
interleaved by point

```
RMS vl vs
rmsvl = 1.11957882866011
rmsvs = 1.02306842574497
a0 = 212.462300956798
a1 = 0.0918302711726546
a2 = -0.0706084406645523
b0 = 406.806585531659
b1 = 0.239669883760274
b2 = 0.395020693429097
c1 = -0.000104645803396593
c2 = 8.50075389136273e-005
di ary off
```

parameter values

1.	37. 79429185239551	-122. 2596788406372
2.	37. 800760358476495	-122. 25484281778335
3.	37. 8051303063828	-122. 26147055625915
4.	37. 81033491179257	-122. 26154029369354
5.	37. 79676741572901	-122. 26687788963318
6.	37. 802125200234485	-122. 27882444858551
7.	37. 80708419555609	-122. 27863132953644
8.	37. 8141491290672	-122. 27623343467712
9.	37. 81824707403118	-122. 27346003055572
10.	37. 81560271779262	-122. 28323936462402
11.	37. 811504626038	-122. 29062616825104
12.	37. 80192598577343	-122. 26692080497741

cnv.m

```
% cnv.m 6-oct-09
```

```
load oakc.txt  
for i=1:12  
    latd=oakc(i,2);  
    lond=oakc(i,3);  
    xy=fgeotm(latd,lond);  
    [xy(1) xy(2)]  
end
```

1	151	514	565179.817698394	oak_spc.txt	4183249.7408979
2	628	487	565599.879094293		4183970.80830301
3	615	335	565012.567395547		4184451.02628986
4	818	273	565001.865695983		4185028.43269697
5	82	371	564543.831859975		4183519.41108453
6	47	178	563487.460503746		4184105.67878736
7	252	137	563500.215237534		4184656.01344967
8	563	98	563705.227866426		4185441.50482183
9	764	87	563945.808303219		4185898.06960555
10	453	35	563087.327584916		4185598.0285359
11	168	14	562440.604331434		4185138.38100085
12	321	304	564535.565075708		4184091.72773269

```

% par8_hw3.m 6-oct-09
load oak_spc.txt

pnum=oak_spc(:, 1);
psx=oak_spc(:, 2);
psy=oak_spc(:, 3);
Xutm=oak_spc(:, 4);
Yutm=oak_spc(:, 5);

Xmean=mean(Xutm);
Ymean=mean(Yutm);
Xmean=round(Xmean);
Ymean=round(Ymean);

X=Xutm-Xmean;
Y=Yutm-Ymean;
s=psx;
l=psy;

disp('size of array X');
[m, n]=size(X);
B=zeros(2*m, 8);
f=zeros(2*m, 1);

for i=1:m
    ii=(i-1)*2 + 1;
    B(ii, :)=[-1 -X(i) -Y(i) 0 0 0 l(i)*X(i) l(i)*Y(i)];
    f(ii)=-l(i);
    ii=ii+1;
    B(ii, :)=[0 0 0 -1 -X(i) -Y(i) s(i)*X(i) s(i)*Y(i)];
    f(ii)=-s(i);
end

N=B'*B;
t=B'*f;
par=inv(N)*t;
v=f - B*par;
sumvl2=0;
sumvs2=0;
for i=1:m
    ii=(i-1)*2 + 1;
    sumvl2=sumvl2 + v(ii)*v(ii);
    ii=ii+1;
    sumvs2=sumvs2 + v(ii)*v(ii);
end
disp('RMS vl vs');
rmsvl=sqrt(sumvl2/m);
rmsvs=sqrt(sumvs2/m);

a0=par(1);
a1=par(2);
a2=par(3);
b0=par(4);
b1=par(5);
b2=par(6);
c1=par(7);
c2=par(8);

```