algorithm in matlab code: rectification

9-1

```
A = imread('photo.jpg','JPEG');
Sz = size(A);
irows = Sz(1);
icols = Sz(2);
Oimg = zeros(nrows,ncols,3,'uint8');
for i = 1:nrows
    for j = 1:ncols
        E = Emin + (j-1)* GSD
        N = Nmax - (i-1)* GSD
```

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9-2

E,N (or X,Y) ⟶ xy image

xy ⟶ l,s or r,c

```
if((l>=1) && (l<=irows) && (s>=1) && (s<=icols))
    l = round(l);   % nearest neighbor
    s = round(s);   % interpolation
    R = A(l,s,1);
    G = A(l,s,2);
    B = A(l,s,3);
else
    R = 128;
    G = 128;
    B = 128;
end
```

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9-3

```
oimg(i,j,1) = R;
oimg(i,j,2) = G;
oimg(i,j,3) = B;
end
end
```

← 0-255

```
image(oimg);  % preview
imwrite(oimg, 'rectimg.jpg', 'JPEG');
```

done with rectification

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9-4

interpolation

(a) up sampling — higher freq. than image
directly interpolate

(b) down sampling — lower freq. than image
consider effects of aliasing
handle by 1st LPF low pass filter
2nd interpolate

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Nyquist sampling rule: you must sample at least 2x per period of the highest freq. present to avoid aliasing

In photogrammetry accomplish LPF: image pyramid.

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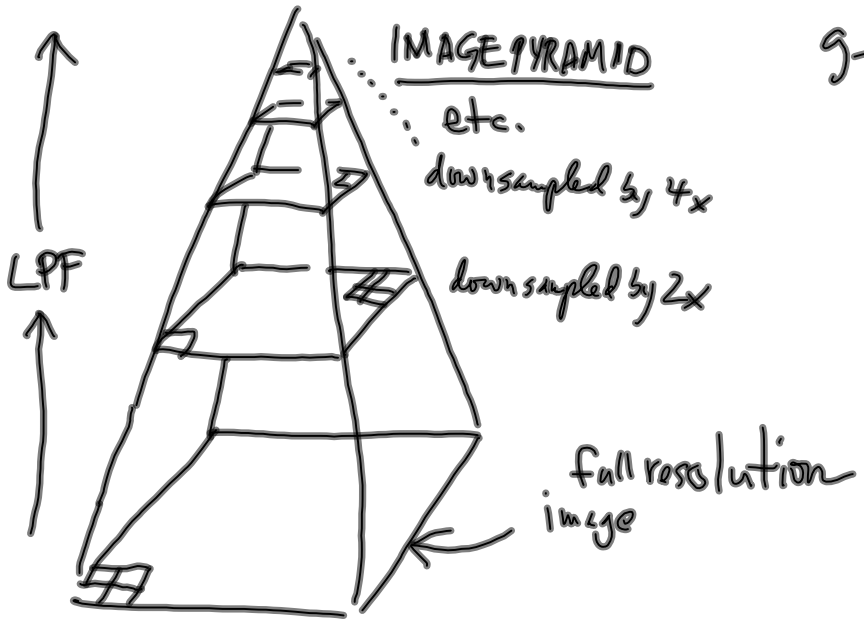

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Interpolation:

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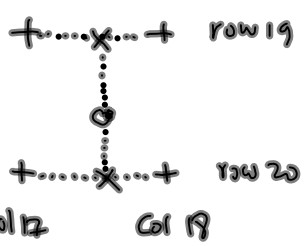
Nearest Neighbor : just round to nearest integer

* Bilinear



rows first then column

19.6, 17.7

(Bicubic also used - we cover it later.)

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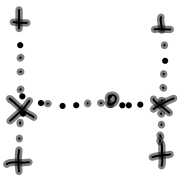
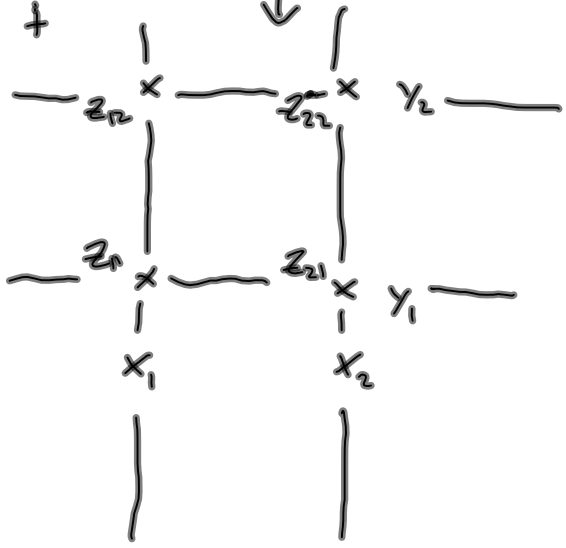
9-8

or colums first than row — it does not matter



more analytical approach - elegant but slow



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9-9

$$z_{11} = a_0 + a_1 x_1 + a_2 y_1 + a_3 x_1 y_1$$
$$z_{21} = a_0 + a_1 x_2 + a_2 y_1 + a_3 x_2 y_1$$
$$z_{12} = a_0 + a_1 x_1 + a_2 y_2 + a_3 x_1 y_2$$
$$z_{22} = a_0 + a_1 x_2 + a_2 y_2 + a_3 x_2 y_2$$

4 linear equations in 4 unknowns

$$\begin{bmatrix} z_{11} \\ z_{21} \\ z_{12} \\ z_{22} \end{bmatrix} = \begin{bmatrix} 1 & x_1 & y_1 & x_1 y_1 \\ 1 & x_2 & y_1 & x_2 y_1 \\ 1 & x_1 & y_2 & x_1 y_2 \\ 1 & x_2 & y_2 & x_2 y_2 \end{bmatrix} \begin{bmatrix} a_0 \\ a_1 \\ a_2 \\ a_3 \end{bmatrix}$$

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9-10

$b = A\,a$

$a = A^{-1} b$

interpolate at x, y

$z = a_0 + a_1 x + a_2 y + a_3 xy$ ↓ interpolation

Using 8-parameter transformation to get approximations for Ext. Or. $X_L Y_L Z_L$, $\omega \phi \kappa$

↓

8-par

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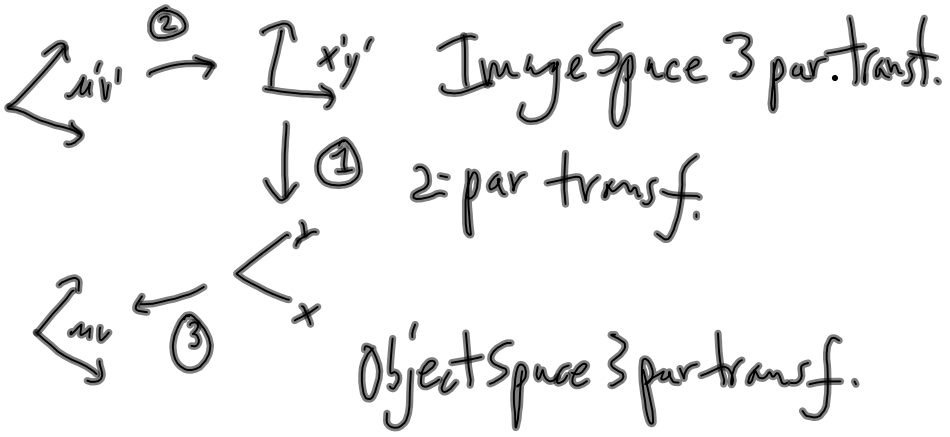
Derivation of 8 parameter transf. how to obtain EO par's. 9-11



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$x' = u' \cos\alpha' + v' \sin\alpha' + d'$
$y' = -u' \sin\alpha' + v' \cos\alpha' + e'$ (image) 9-12

$u = x \cos\alpha + y \sin\alpha + d$
$v = -x \sin\alpha + y \cos\alpha + e$ (object)

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