Corners

Examples
Example – Corner interest operator

• Apply the corner interest operator to an image of a square
  – Square is size 200x200, image is size 400x400
  – Look at matrix A at a corner and along an edge

\[
A = w^* \begin{pmatrix} I_x^2 & I_{xy} \\ I_{xy} & I_y^2 \end{pmatrix}
\]

where

\[
I_x^2 = \left( \frac{\partial I}{\partial x} \right)^2, \quad I_{xy} = \left( \frac{\partial I}{\partial x} \right) \left( \frac{\partial I}{\partial y} \right),
\]

\[
I_y^2 = \left( \frac{\partial I}{\partial y} \right)^2
\]

Note – the “*” indicates correlation of w with each element of A

For this example, say w is a square box filter of size N x N
Matlab Corner Interest Operator

• Find A at the corner point (100,100)

```matlab
% Here is A at point (100,100)
A1 = [ A11(100,100) A12(100,100);
      A12(100,100) A22(100,100) ];
disp(A1);
```

• Find A along an edge, such as (200,100)

```matlab
% Here is A at point (200,100)
A2 = [ A11(200,100) A12(200,100);
      A12(200,100) A22(200,100) ];
disp(A2);
```
“Cornerness” Value

• Harmonic mean:

• Shi-Tomasi:

• Harris (use $\alpha = 0.06$):
Example – Square image

• Note – interest point is not detected at the true location of the corner

closeup of detected corner
Neighborhood summing

• Recall that we create a matrix $A$ at each pixel

\[
A = w^* \begin{pmatrix} I_x^2 & I_{xy} \\ I_{xy} & I_y^2 \end{pmatrix}
\]

where

\[
I_x^2 = \left( \frac{\partial I}{\partial x} \right)^2, \quad I_{xy} = \left( \frac{\partial I}{\partial x} \right) \left( \frac{\partial I}{\partial y} \right), \quad I_y^2 = \left( \frac{\partial I}{\partial y} \right)^2
\]

Note – the “*” indicates correlation of $w$ with each element of $A$

• In the previous code, $w$ is a NxN filter of all 1’s
  – However, it would be better to use a filter that gives greater weight to the center of the filter
  – For example, use a Gaussian of size NxN, sigma = 2
    (suggested by our textbook author on page 215)
Use Gaussian weights for integration

• Replace \( w \) filter with a Gaussian:

```matlab
% Size of neighborhood over which to compute corner features.
N = 13;

% The neighborhood
si = 2;
w = fspecial('gaussian', N, si); % The neighborhood

% Sum the G's over the window size.
All = imfilter(Gxx, w);
```

![closeup of detected corner](image)