CSC420 Assignment 2

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```
% Given an image, perform Harris corner detection and return the result image
function harris(im)
img = rgb2gray(im);

[Ix, Iy] = imgradientxy(img); % Compute the gradients Ix and Iy
Ix2 = Ix.^2;
Iy2 = Iy.^2;
Ixy = Ix.*Iy;

% Convolve the computed gradients with a Gaussian filter
gaussian = fspecial('gaussian');
gIx2 = imfilter(Ix2, gaussian, 'same', 'conv');
gIy2 = imfilter(Iy2, gaussian, 'same', 'conv');
gIxy = imfilter(Ixy, gaussian, 'same', 'conv');

height = size(im, 1);
width = size(im, 2);
alpha = 0.06;
R = zeros(height, width);

% Compute M and R for every pixel
for i = 1:height
    for j = 1:width
        M = [gIx2(i, j) gIxy(i, j); ...
             gIxy(i, j) gIy2(i, j)];
        detM = (gIx2(i, j) * gIy2(i, j)) - gIxy(i, j)^2;
        traceM = gIx2(i, j) + gIy2(i, j);
        R(i, j) = detM - (alpha * traceM ^ 2);
    end
end

% Keep track of the points to plot
X = [];
```

```
Y = [];

threshold = max(max(R)) * 0.03; % R threshold

% Perform non-maximum suppression by checking surrounding R values for a
% local maxima with a radius of 1
for i = 2:height - 1
    for j = 2:width - 1
        if R(i, j) > threshold && R(i, j) > R(i - 1, j + 1) && R(i, j) > R(i, j + 1) &&
                R(i, j) > R(i + 1, j + 1) && R(i, j) > R(i - 1, j) && R(i, j) > R(i + 1, j) &&
            R(i, j) > R(i - 1, j - 1) && R(i, j) > R(i, j - 1) && R(i, j) > R(i - 1, j + 1)
            X(end+1) = j;
            Y(end+1) = i;
        end
    end
end

% Display the results of the computations
figure, imshow(Ix, []), title('Ix')
figure, imshow(Iy, []), title('Iy')
figure, imshow(Ix2, []), title('Ix2')
figure, imshow(Iy2, []), title('Iy2')
figure, imshow(Ixy, []), title('Ixy')
figure, imshow(gIx2, []), title('gIx2')
figure, imshow(gIy2, []), title('gIy2')
figure, imshow(gIxy, []), title('gIxy')
figure, imshow(R, []), title('R');
figure, imshow(img), title('corners');
hold on;
plot(X, Y, 'R+');
end
```

(a) Compute I_x^2, I_y^2, $I_x I_y$ and the matrix M for every pixel.

```
img = rgb2gray(im);

[Ix, Iy] = imgradientxy(img); % Compute the gradients Ix and Iy
Ix2 = Ix.^2;
Iy2 = Iy.^2;
Ixy = Ix.*Iy;

% Convolve the computed gradients with a Gaussian filter
gaussian = fspecial('gaussian');
gIx2 = imfilter(Ix2, gaussian, 'same', 'conv');
gIy2 = imfilter(Iy2, gaussian, 'same', 'conv');
gIxy = imfilter(Ixy, gaussian, 'same', 'conv');

```

```
height = size(im, 1);
width = size(im, 2);
alpha = 0.06;
R = zeros(height, width);

% Compute M and R for every pixel
for i = 1:height
    for j = 1:width
        M = [gIx2(i, j) gIxy(i, j); gIxy(i, j) gIy2(i, j)];
    end
end
```

(b) Given the matrix A = $\begin{pmatrix} a & b \\ c & d \end{pmatrix}$, the determinant $det(A) = ad - cb$, and $trace(A) = a + d$. The equation to compute the cornerness measure R in each pixel is $R = det(M) - \alpha trace(M)^2 = ad - cb - \alpha(a + d)^2$.

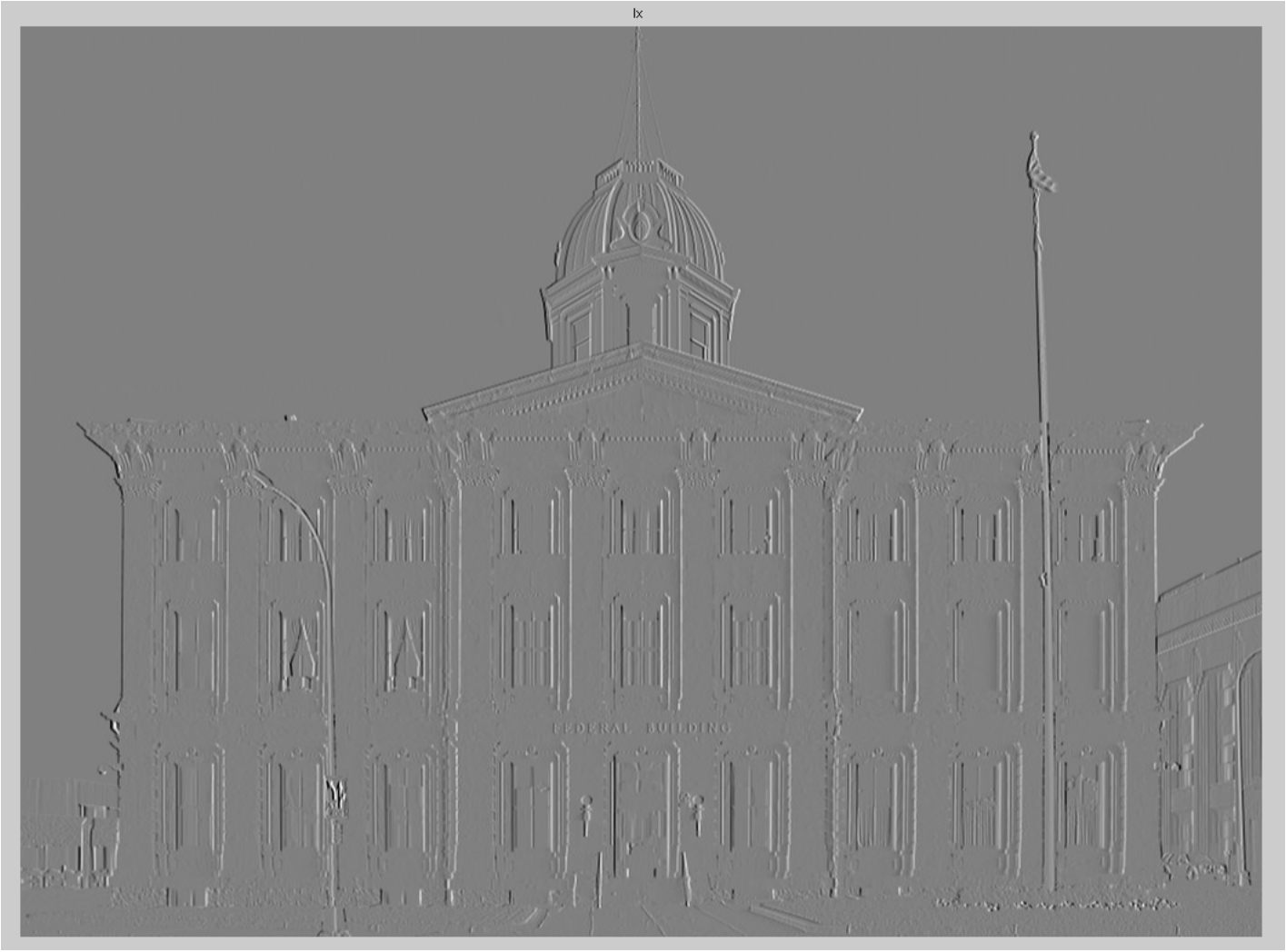
(c) Compute R for every pixel.

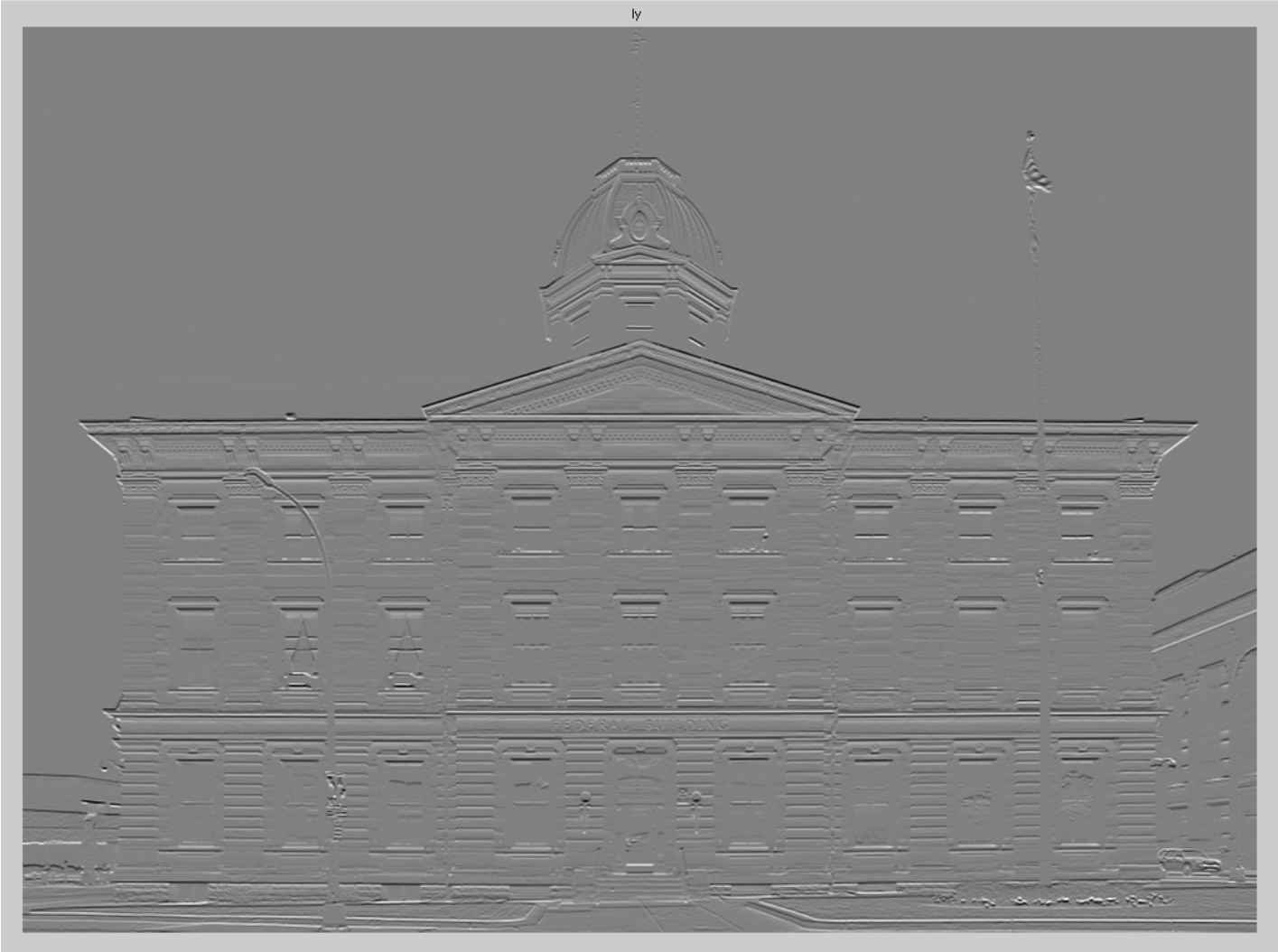
```
% Convolve the computed gradients with a Gaussian filter
gaussian = fspecial('gaussian');
gIx2 = imfilter(Ix2, gaussian, 'same', 'conv');
gIy2 = imfilter(Iy2, gaussian, 'same', 'conv');
gIxy = imfilter(Ixy, gaussian, 'same', 'conv');

height = size(im, 1);
width = size(im, 2);
alpha = 0.06;
R = zeros(height, width);

% Compute M and R for every pixel
for i = 1:height
    for j = 1:width
        M = [gIx2(i, j) gIxy(i, j); ...
             gIxy(i, j) gIy2(i, j)];
        detM = (gIx2(i, j) * gIy2(i, j)) - gIxy(i, j)^2;
        traceM = gIx2(i, j) + gIy2(i, j);
        R(i, j) = detM - (alpha * traceM ^ 2);
    end
end
```

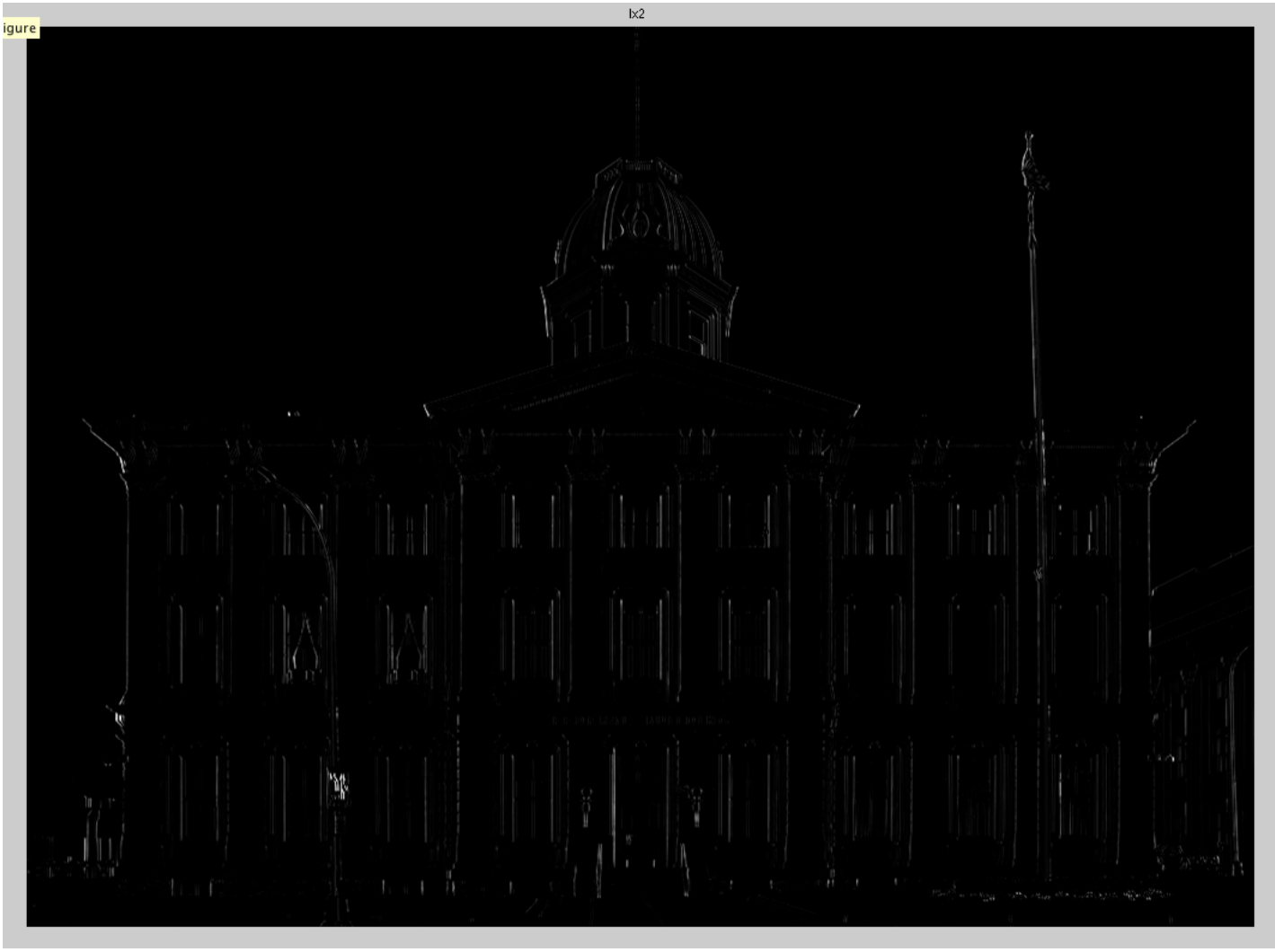
(d) Compute Threshold R and perform non-maxima suppression.

```
% Keep track of the points to plot
X = [];
Y = [];

```

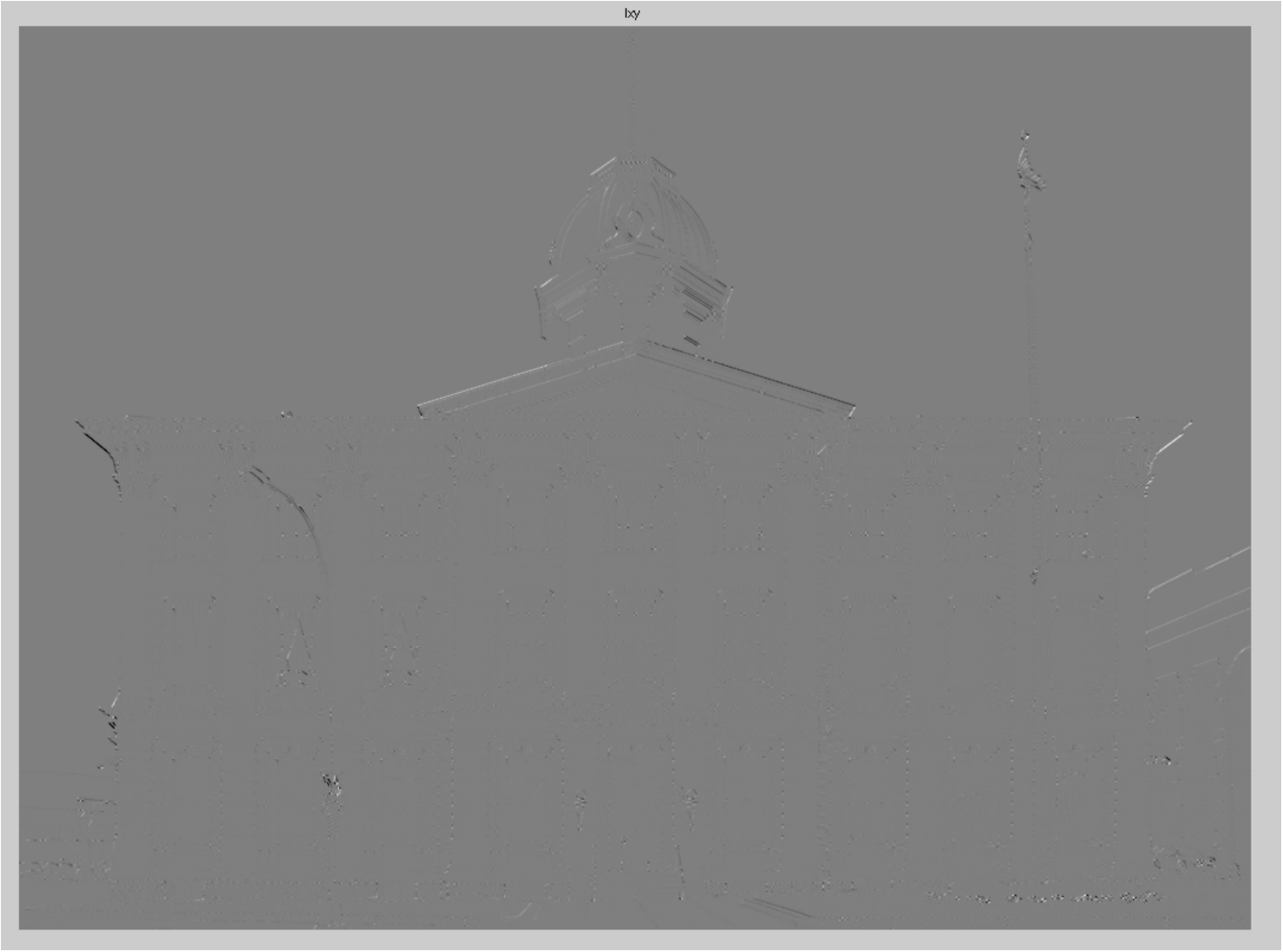
```
threshold = max(max(R)) * 0.03; % R threshold

% Perform non-maximum suppression by checking surrounding R values for a
% local maxima with a radius of 1
for i = 2:height - 1
    for j = 2:width - 1
        if R(i, j) > threshold && R(i, j) > R(i - 1, j + 1) && R(i, j) > R(i, j + 1) &&
                R(i, j) > R(i + 1, j + 1) && R(i, j) > R(i - 1, j) && R(i, j) > R(i + 1, j) &&
            R(i, j) > R(i - 1, j - 1) && R(i, j) > R(i, j - 1) && R(i, j) > R(i - 1, j + 1)
            X(end+1) = j;
            Y(end+1) = i;
        end
    end
end

figure, imshow(img), title('corners');
hold on;
plot(X, Y, 'R+');
```

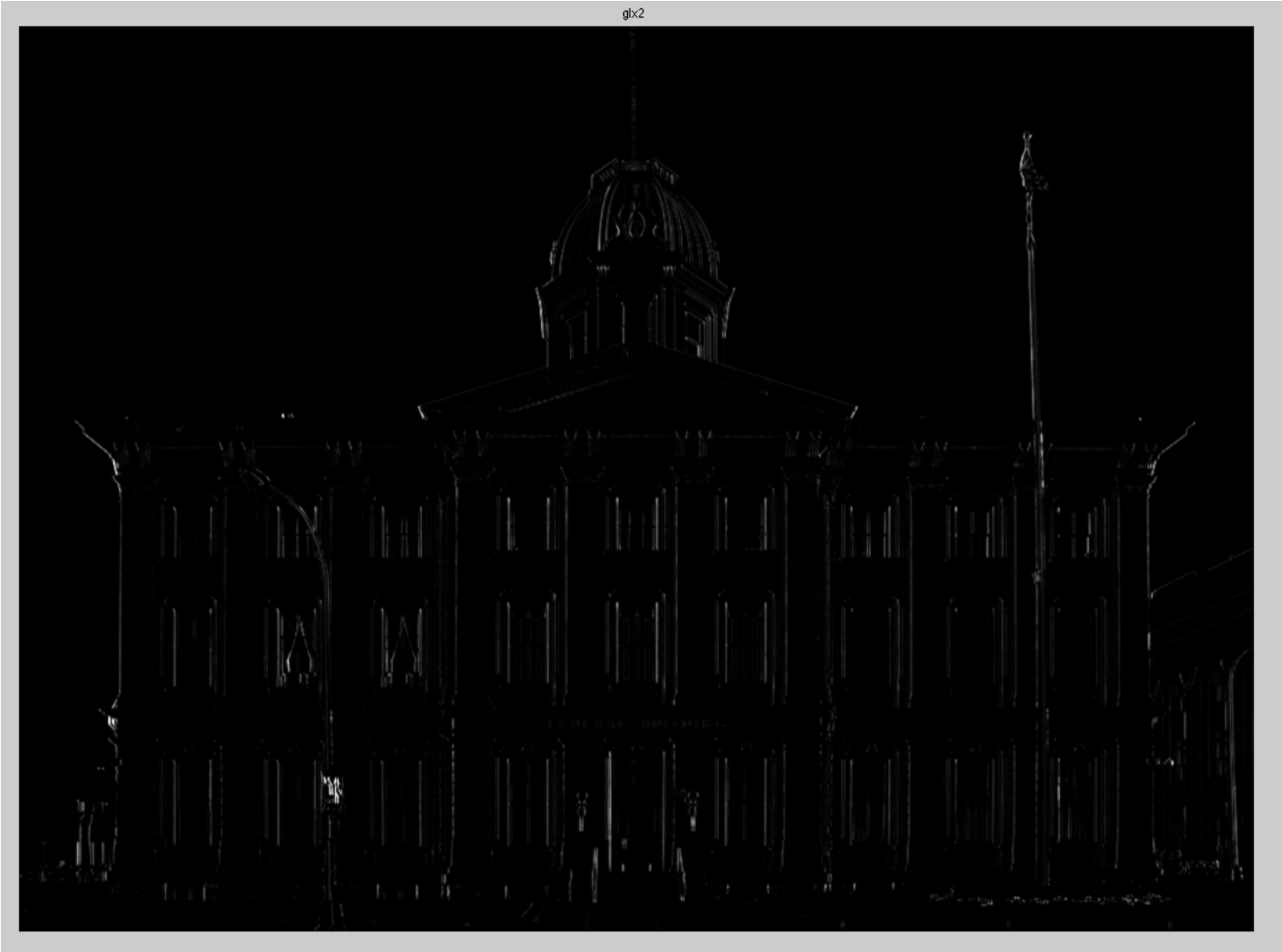


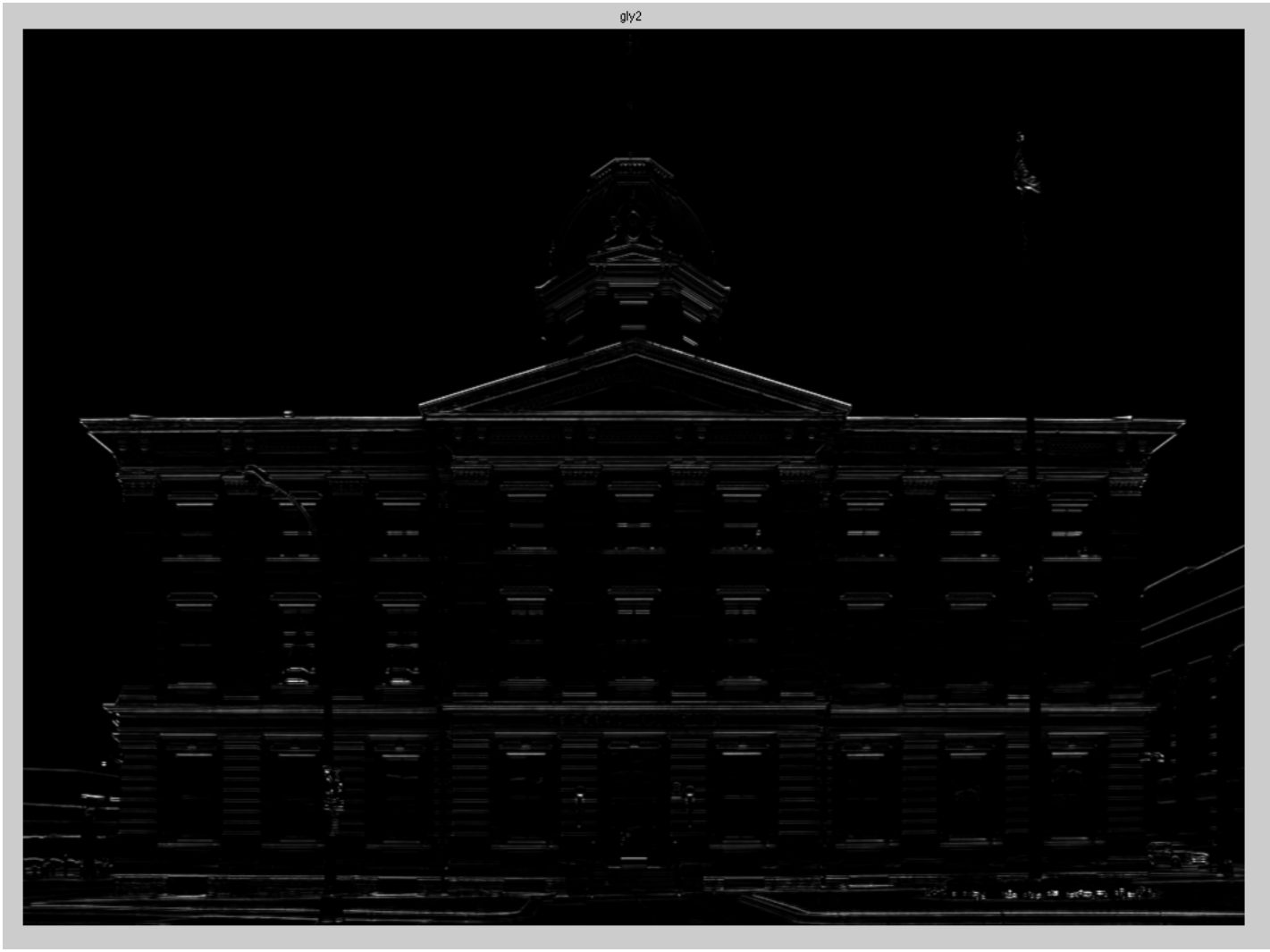

Iy

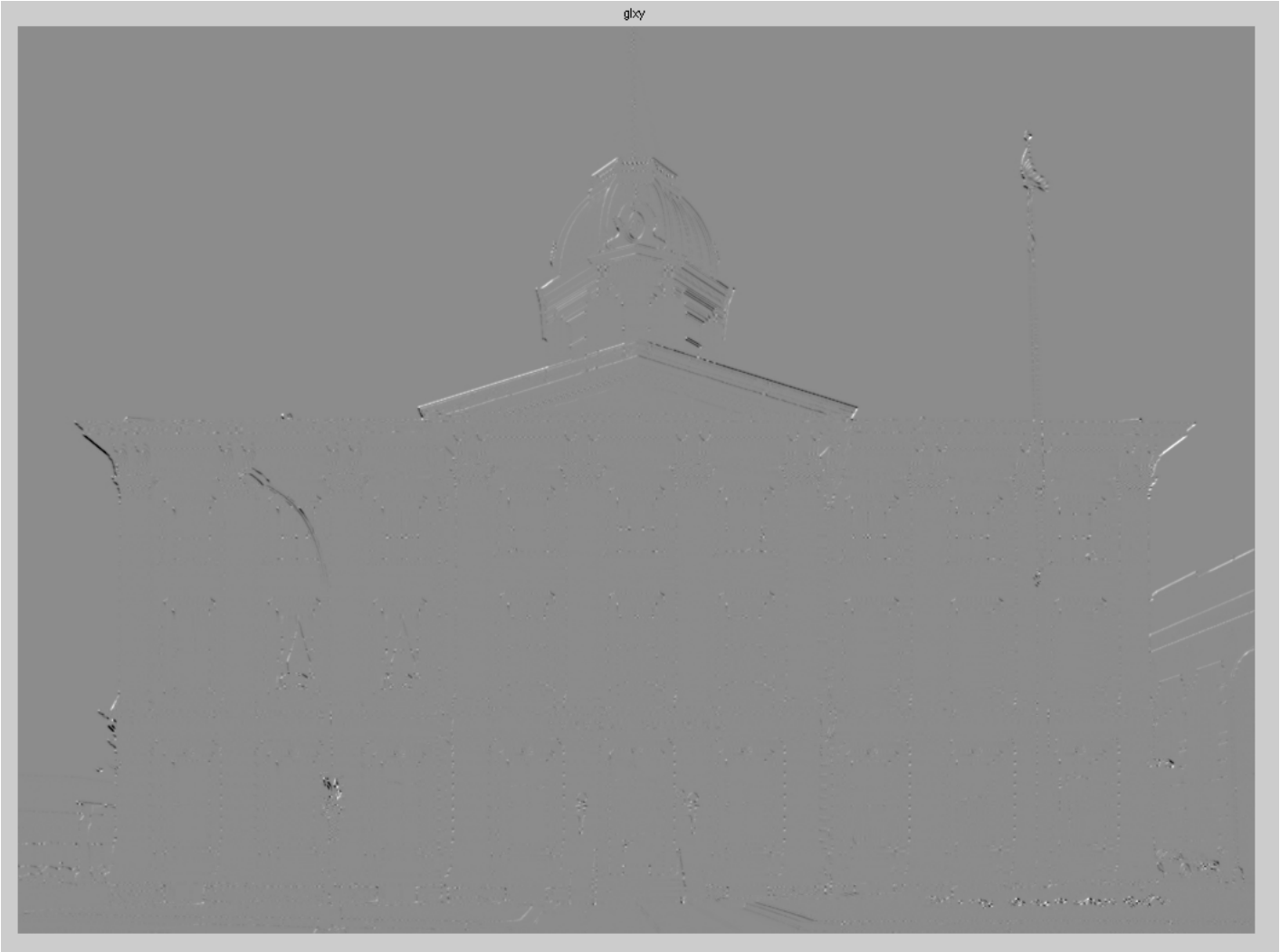

Ix2
igure

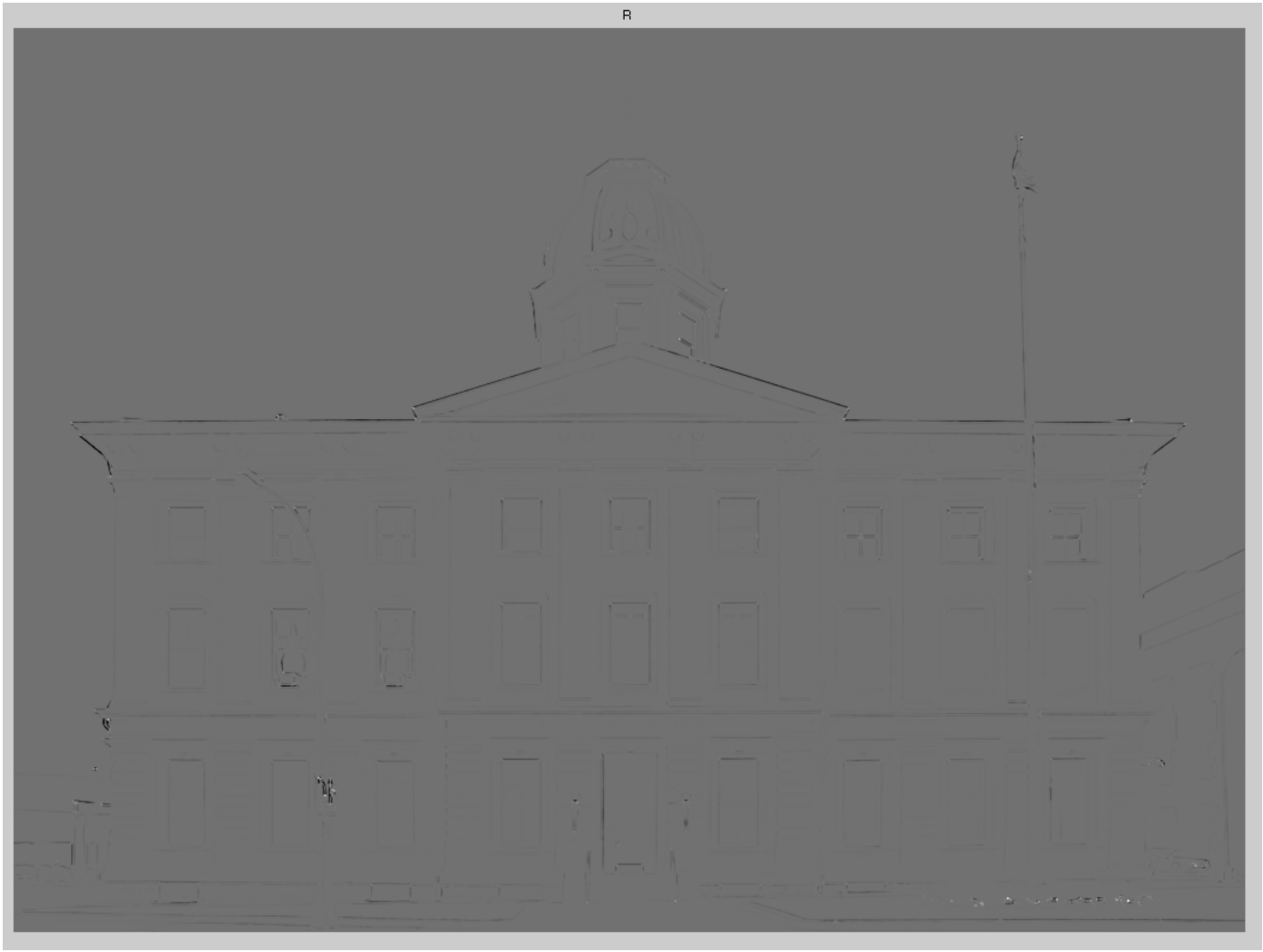

Iy2


Ixy


gIx2


gly2


glxy


R

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