```matlab
% Histogram Equalization Implementation for Grayscale Images
% Enhances image contrast by equalizing the probability distribution of intensity values
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clear all
close all
clc

% File selection dialog
[filename, pathname] = uigetfile({'*.jpg;*.png;*.bmp;*.tif', 'Image Files (*.jpg,*.png,*.bmp,*.tif)';
                                 '*.*', 'All Files (*.*)'}, ...
                                 'Select an Image File');

if filename == 0
    disp('User canceled file selection');
    return;
end

% Read the selected image
img = imread(fullfile(pathname, filename));

% Convert to grayscale if needed
if size(img, 3) == 3
    gray_img = rgb2gray(img);
else
    gray_img = img;
end

% Calculate histogram
[counts, bins] = histcounts(gray_img(:), 256);

% Calculate CDF
cdf = cumsum(counts) / numel(gray_img);

% Manual histogram equalization
% Create lookup table
cdf_min = min(cdf(cdf > 0));  % Find first non-zero value
lookup_table = uint8(round((cdf - cdf_min) / (1 - cdf_min) * 255));

% Apply lookup table to create equalized image
equalized_img = lookup_table(gray_img + 1);  % +1 because MATLAB is 1-based indexed

% Create subplots for visualization
figure('Position', [100 100 1200 600]);

% Original image
subplot(2, 3, 1);
imshow(gray_img);
title('Original Grayscale Image');

% Original histogram
subplot(2, 3, 2);
bar(bins(1:end-1), counts);
title('Original Histogram');
xlabel('Intensity Value');
ylabel('Frequency');
grid on;

% Original CDF
subplot(2, 3, 3);
plot(bins(1:end-1), cdf);
title('Original CDF');
xlabel('Intensity Value');
ylabel('Cumulative Probability');
grid on;

% Equalized image
subplot(2, 3, 4);
imshow(equalized_img);
title('Equalized Image');

% Equalized histogram
[eq_counts, eq_bins] = histcounts(equalized_img(:), 256);
subplot(2, 3, 5);
bar(eq_bins(1:end-1), eq_counts);
title('Equalized Histogram');
xlabel('Intensity Value');
ylabel('Frequency');
grid on;

% Equalized CDF
eq_cdf = cumsum(eq_counts) / numel(equalized_img);
subplot(2, 3, 6);
plot(eq_bins(1:end-1), eq_cdf);
title('Equalized CDF');
xlabel('Intensity Value');
ylabel('Cumulative Probability');
grid on;
```
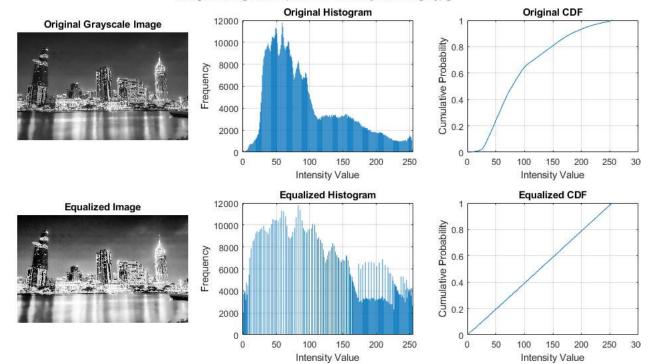
```
% Adjust subplot spacing
sgtitle(['Image Histogram Equalization Analysis: ' filename]);
```


Image Histogram Equalization Analysis: image.jpg