

Assignment for Image Recognition and Understanding

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1. environment:

Python3.8.1

opencv

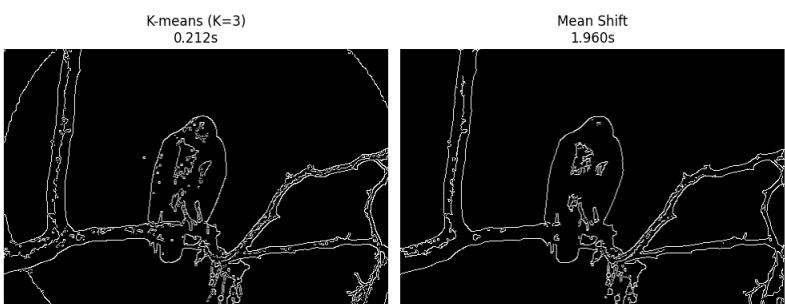
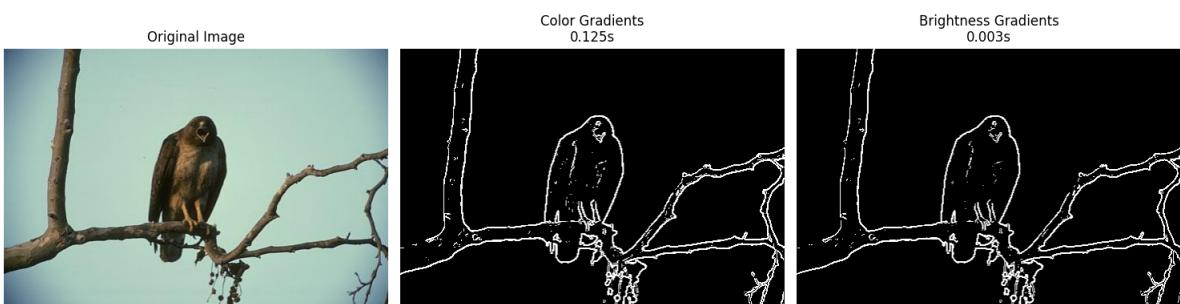
2. Segmentation Algorithm:

Color gradient detection calculates the gradient in LAB color space, combines the gradient information of the three channels and uses Otsu thresholding. Brightness gradient detection uses the grayscale image to calculate the Sobel gradient and uses Otsu thresholding. K-means segmentation performs clustering in LAB color space and applies Canny edge detection to the segmentation results with an adjustable K value. Mean shift segmentation uses pyrMeanShiftFiltering to apply Canny edge detection to the segmentation results.

Use four methods: Color Gradients, Brightness Gradients, Color K-Means (K value is provided by the description on each page), and Mean Shift to detect five images. Change some parameters of each image and perform two.

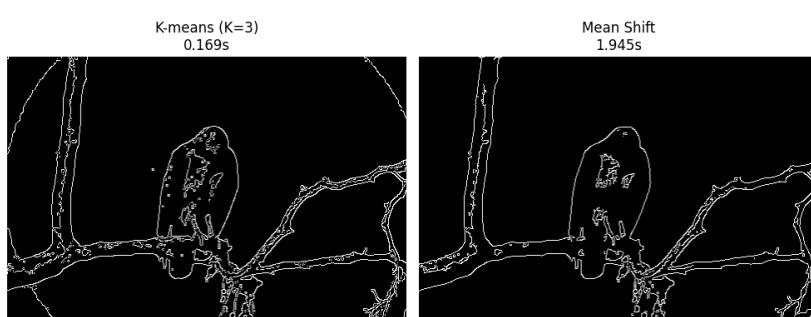
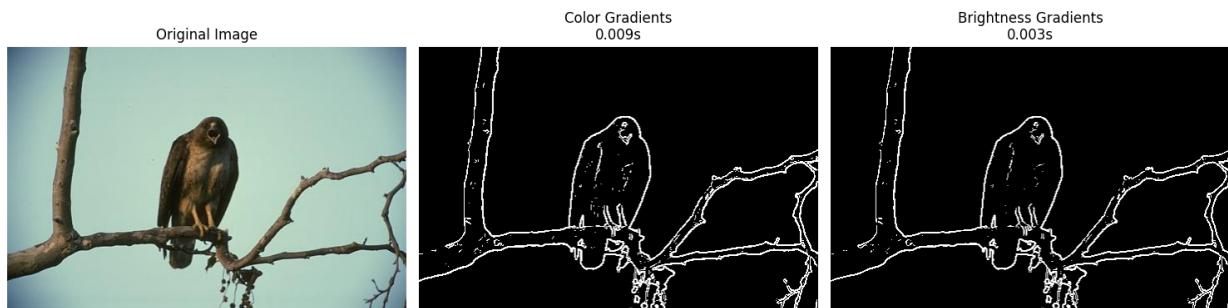
- Color gradient detection:

Figure 1



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Figure 1



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Figure 1

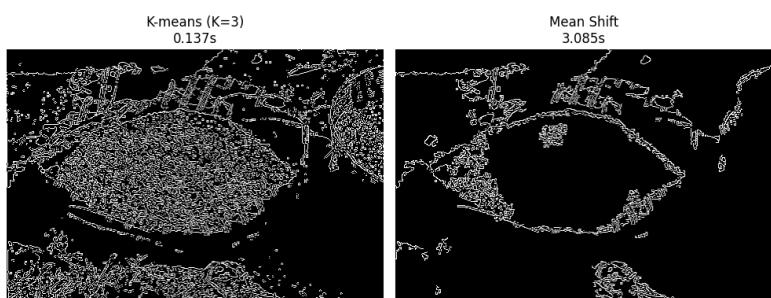
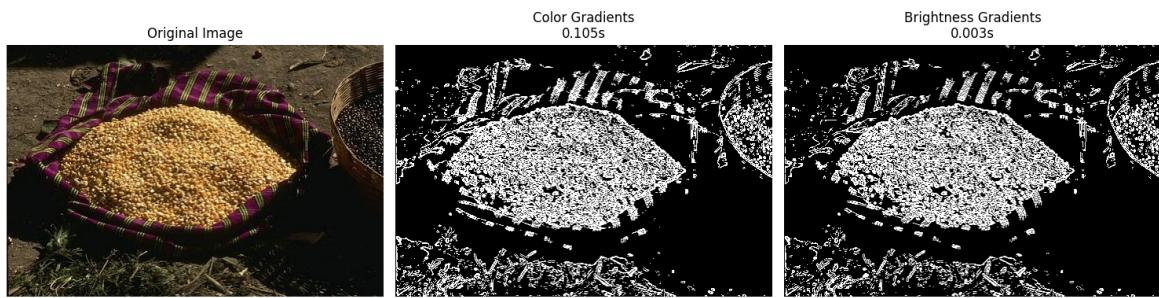


Figure 1

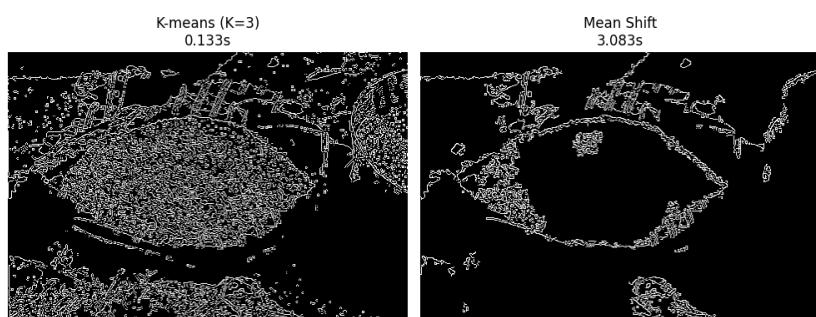
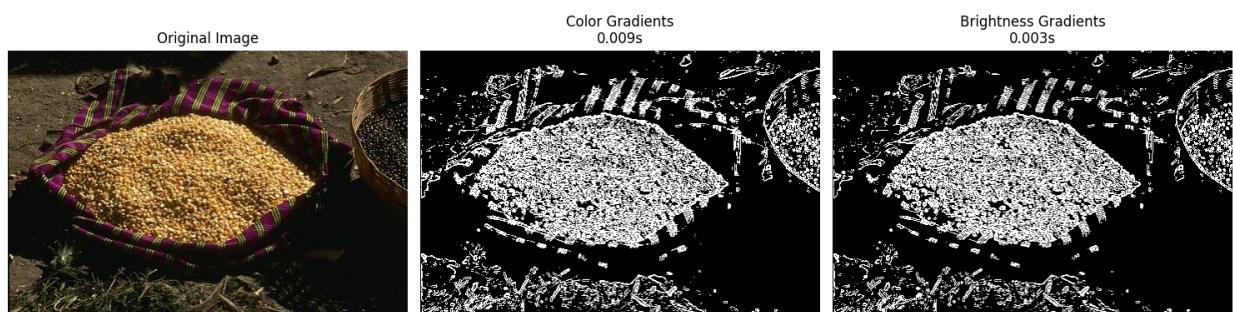


Figure 1

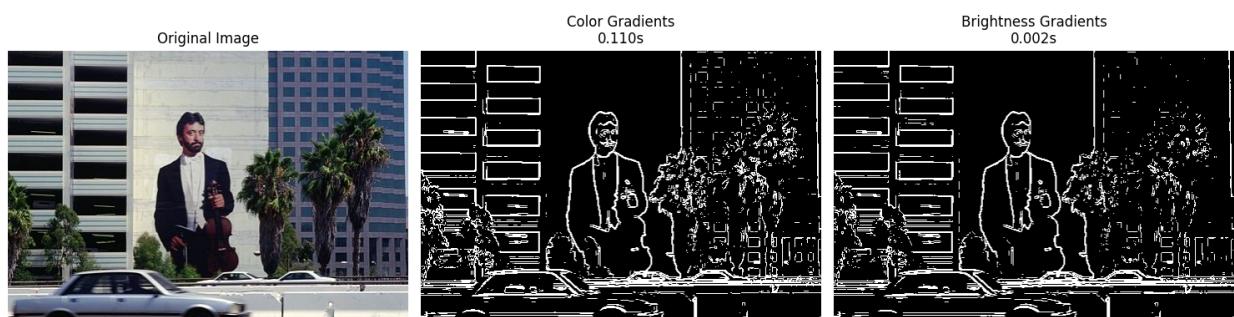


Figure 1

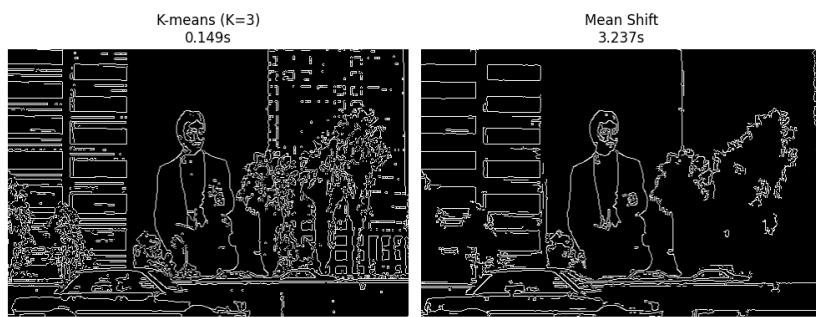
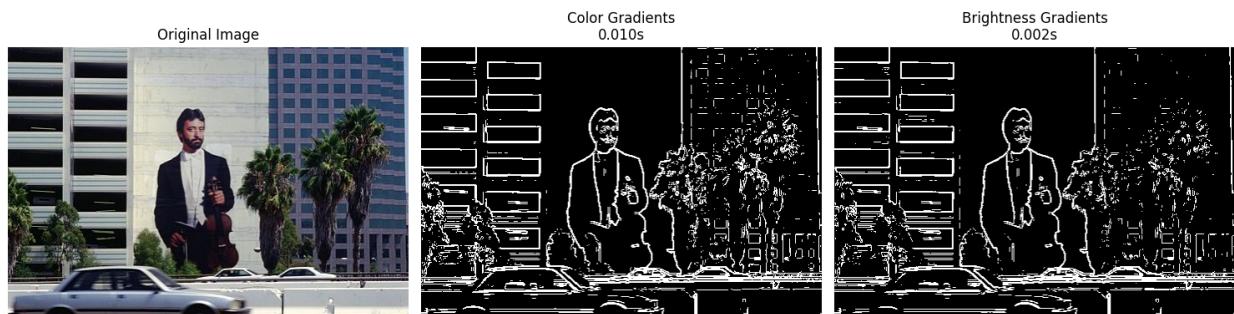


Figure 1

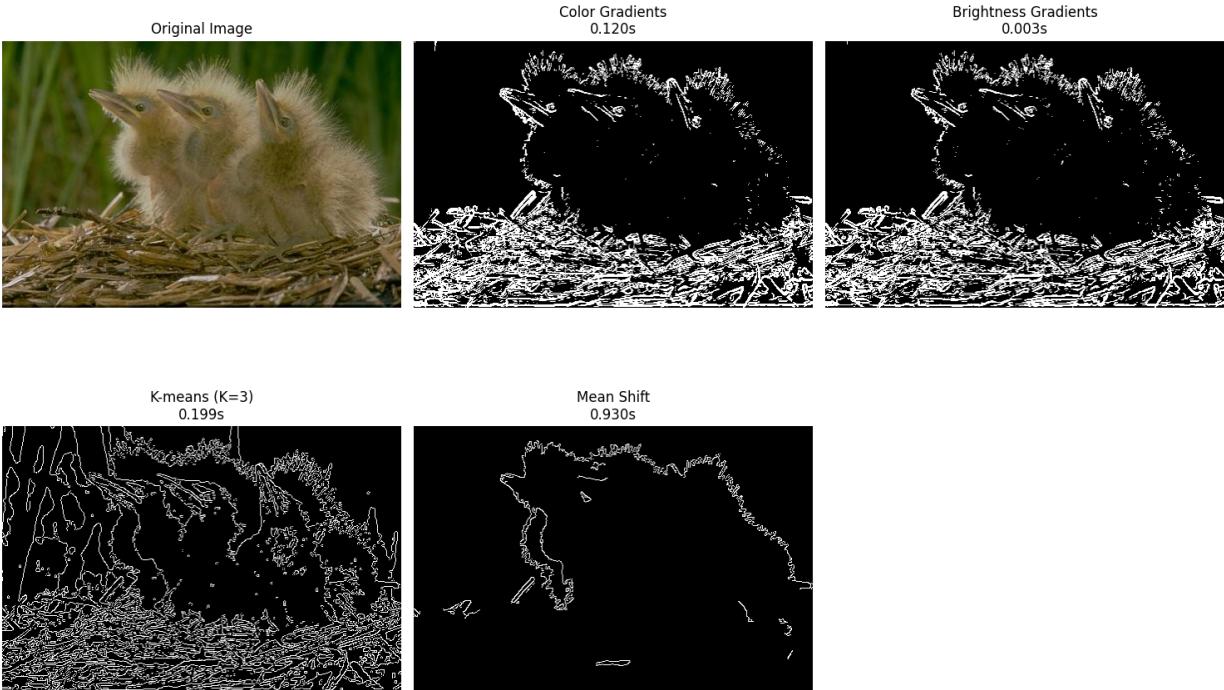


Figure 1

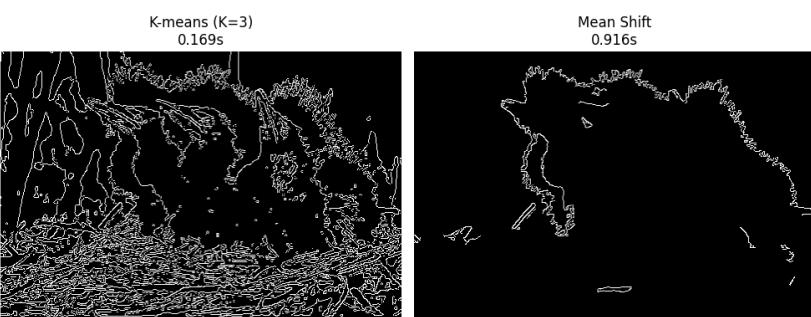
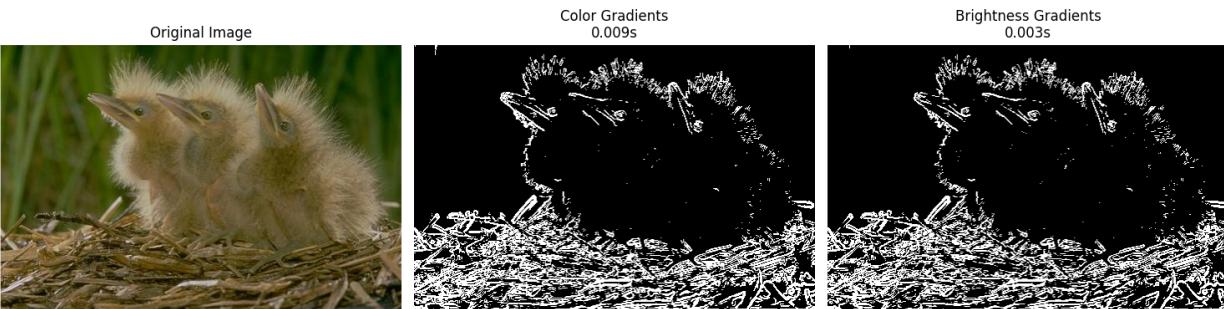


Figure 1

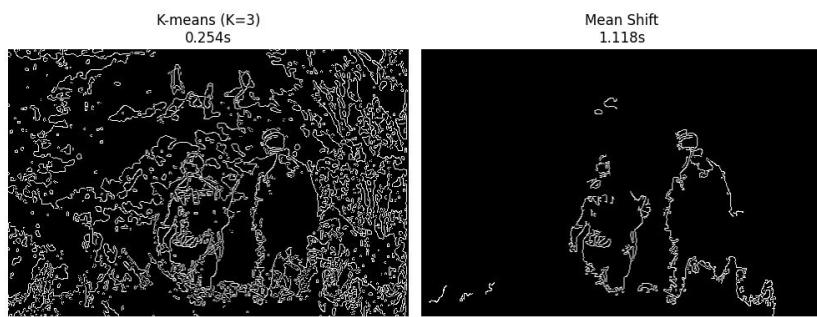
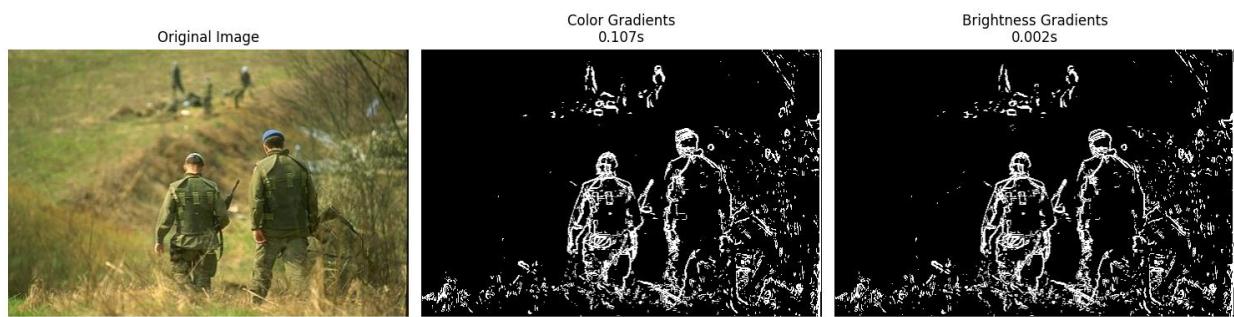
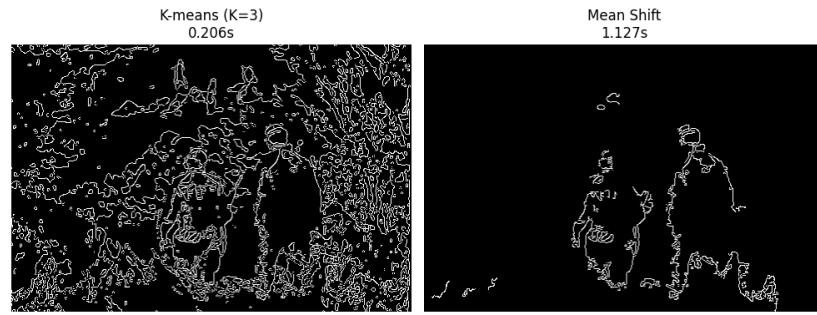
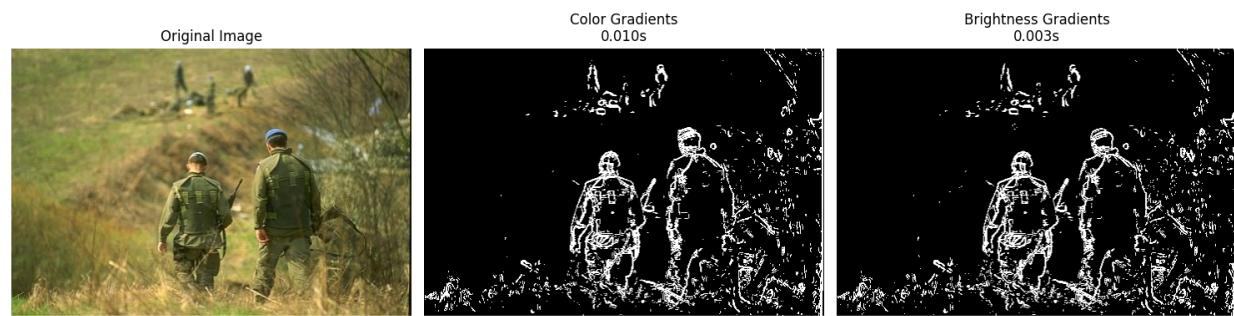


Figure 1



3. Evaluation Methodology:

Use Recall, Precision, and F-Measure to evaluate the segmentation effect. The following figure shows the evaluation during the processing, and more detailed evaluation parameters are also printed in the console.

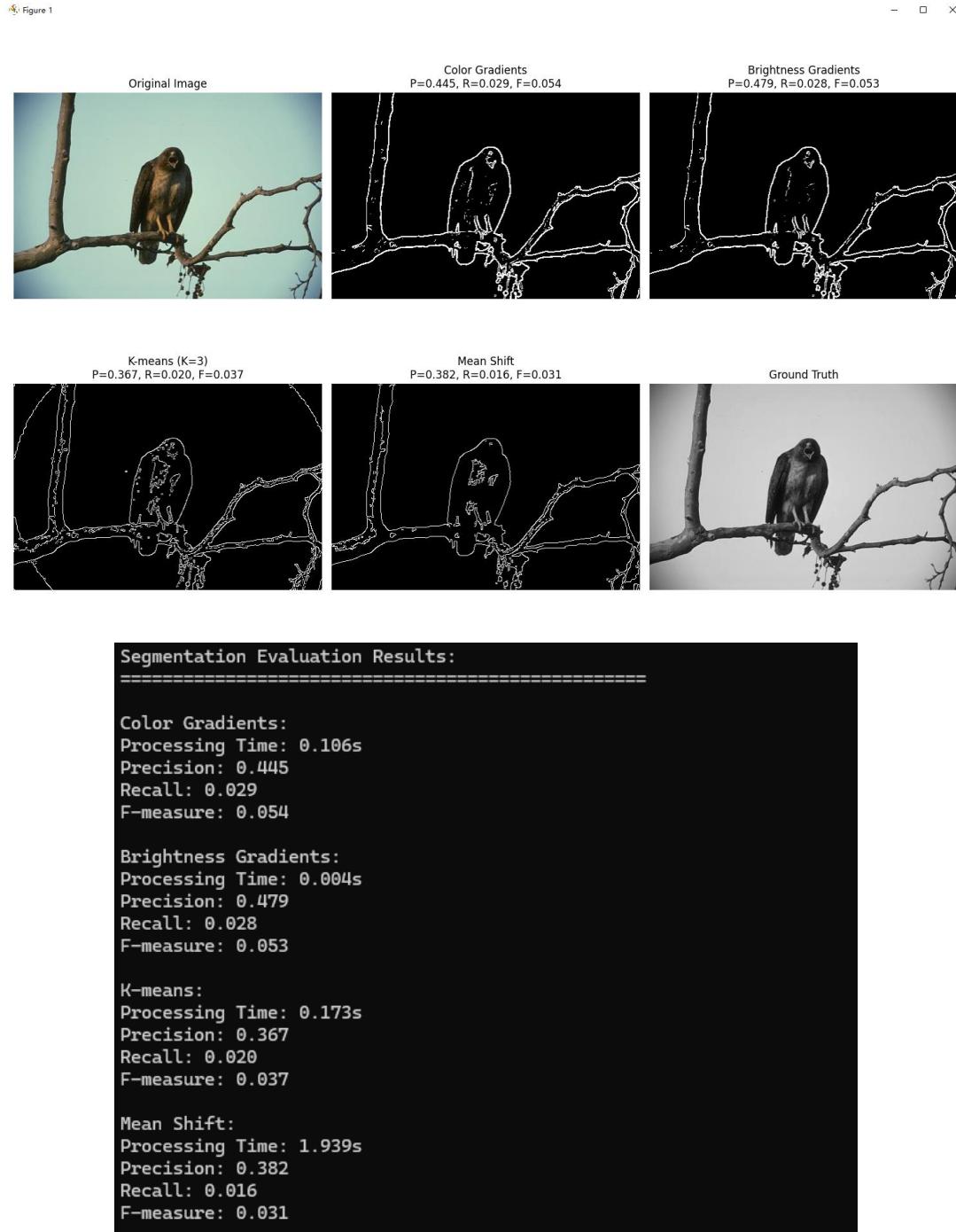
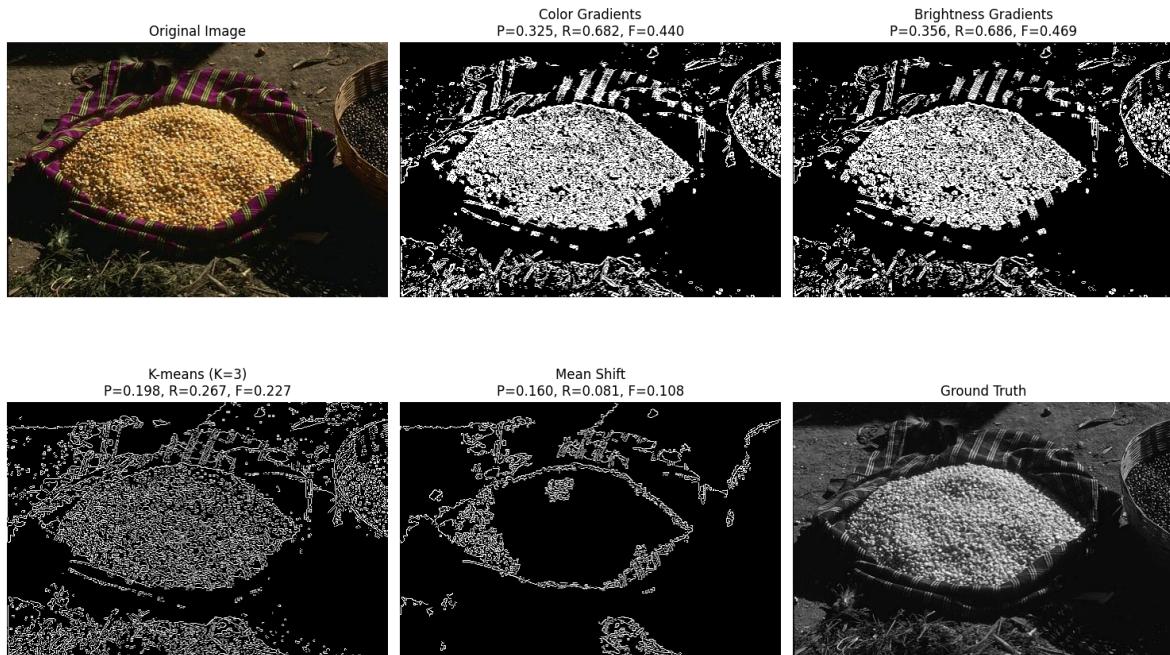


Figure 1

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Segmentation Evaluation Results:

Color Gradients:

Processing Time: 0.110s
Precision: 0.325
Recall: 0.682
F-measure: 0.440

Brightness Gradients:

Processing Time: 0.003s
Precision: 0.356
Recall: 0.686
F-measure: 0.469

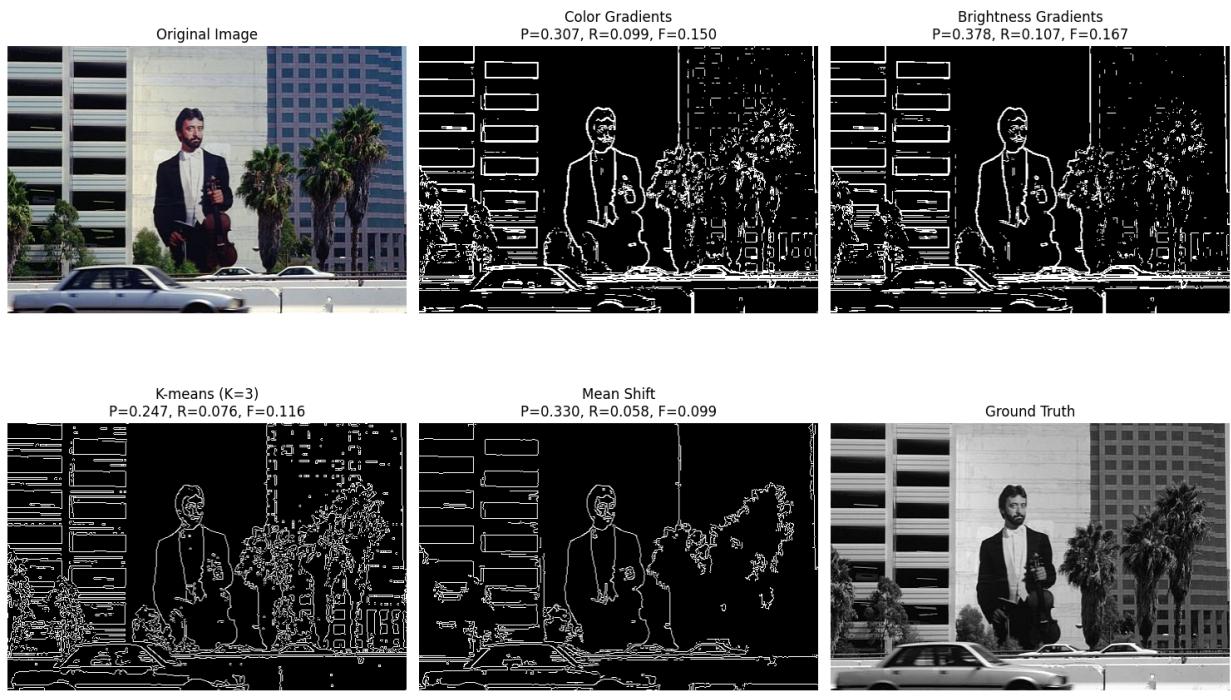
K-means:

Processing Time: 0.147s
Precision: 0.198
Recall: 0.267
F-measure: 0.227

Mean Shift:

Processing Time: 3.086s
Precision: 0.160
Recall: 0.081
F-measure: 0.108

Figure 1



Segmentation Evaluation Results:

Color Gradients:

Processing Time: 0.105s
Precision: 0.307
Recall: 0.099
F-measure: 0.150

Brightness Gradients:

Processing Time: 0.002s
Precision: 0.378
Recall: 0.107
F-measure: 0.167

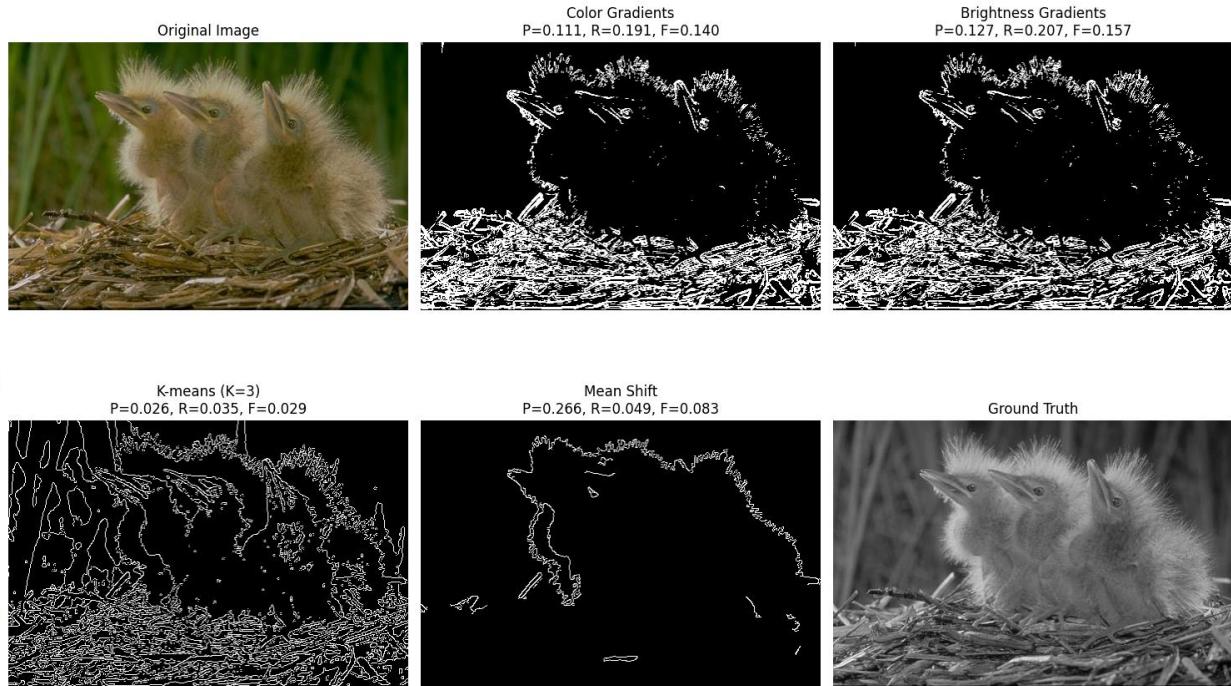
K-means:

Processing Time: 0.170s
Precision: 0.247
Recall: 0.076
F-measure: 0.116

Mean Shift:

Processing Time: 3.271s
Precision: 0.330
Recall: 0.058
F-measure: 0.099

Figure 1



Segmentation Evaluation Results:

Color Gradients:

Processing Time: 0.107s
Precision: 0.111
Recall: 0.191
F-measure: 0.140

Brightness Gradients:

Processing Time: 0.003s
Precision: 0.127
Recall: 0.207
F-measure: 0.157

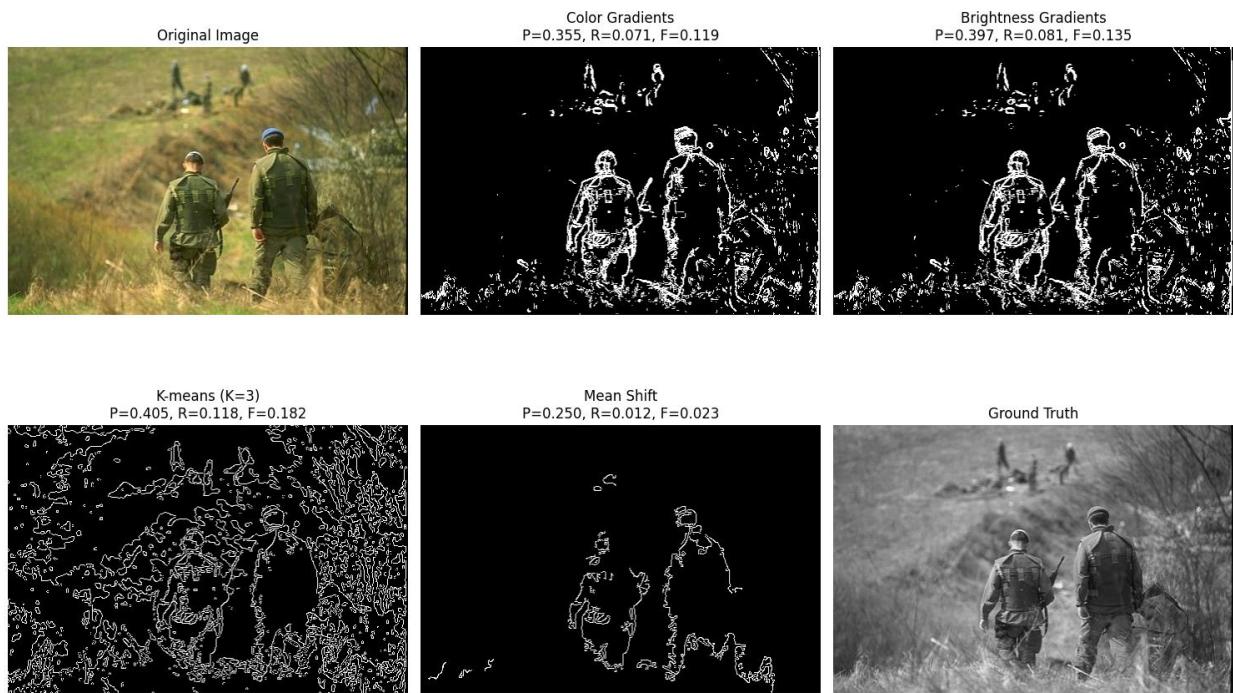
K-means:

Processing Time: 0.221s
Precision: 0.026
Recall: 0.035
F-measure: 0.029

Mean Shift:

Processing Time: 0.918s
Precision: 0.266
Recall: 0.049
F-measure: 0.083

Figure 1



Segmentation Evaluation Results:

Color Gradients:

Processing Time: 0.104s
Precision: 0.355
Recall: 0.071
F-measure: 0.119

Brightness Gradients:

Processing Time: 0.003s
Precision: 0.397
Recall: 0.081
F-measure: 0.135

K-means:

Processing Time: 0.190s
Precision: 0.405
Recall: 0.118
F-measure: 0.182

Mean Shift:

Processing Time: 1.135s
Precision: 0.250
Recall: 0.012
F-measure: 0.023

4. method analysis:

1. Color Gradients

Advantages:

- Capable of capturing boundaries of color changes
- Good effect on areas with strong color contrast
- Fast processing speed

Disadvantages:

- Sensitive to noise
- May produce false boundaries in color gradient areas
- Precision is generally low, indicating that over-detection is likely to occur

2. Brightness Gradients

Advantages:

- Simple calculation and fastest processing speed
- Good detection effect on obvious brightness boundaries
- High precision in some scenes

Disadvantages:

- Ignores color information
- Poor performance in areas with similar brightness but different colors
- Recall is relatively low, indicating that it is easy to miss detections

3. K-means segmentation

Advantages:

- Able to segment regions based on color features
- Good segmentation effect for large areas
- F-measure is relatively balanced and has good overall performance

Disadvantages:

- Need to pre-specify K value
- High computational complexity
- Results are affected by the initial cluster center

4. Mean Shift

Advantages:

- No need to preset the number of categories
- Can adaptively find the density center
- Good boundary preservation performance

Disadvantages:

- Longest computation time
- More complex parameter settings
- May over-segment in some cases

5.Comprehensive performance analysis:

1. Precision:

- K-means and Mean Shift generally have good precision
- Color Gradients has relatively low precision

2. Recall:

- Color Gradients usually have high recall
- Brightness Gradients has low recall

3. F-measure:

- K-means has good F-measure in most cases
- Mean Shift's F-measure is relatively stable