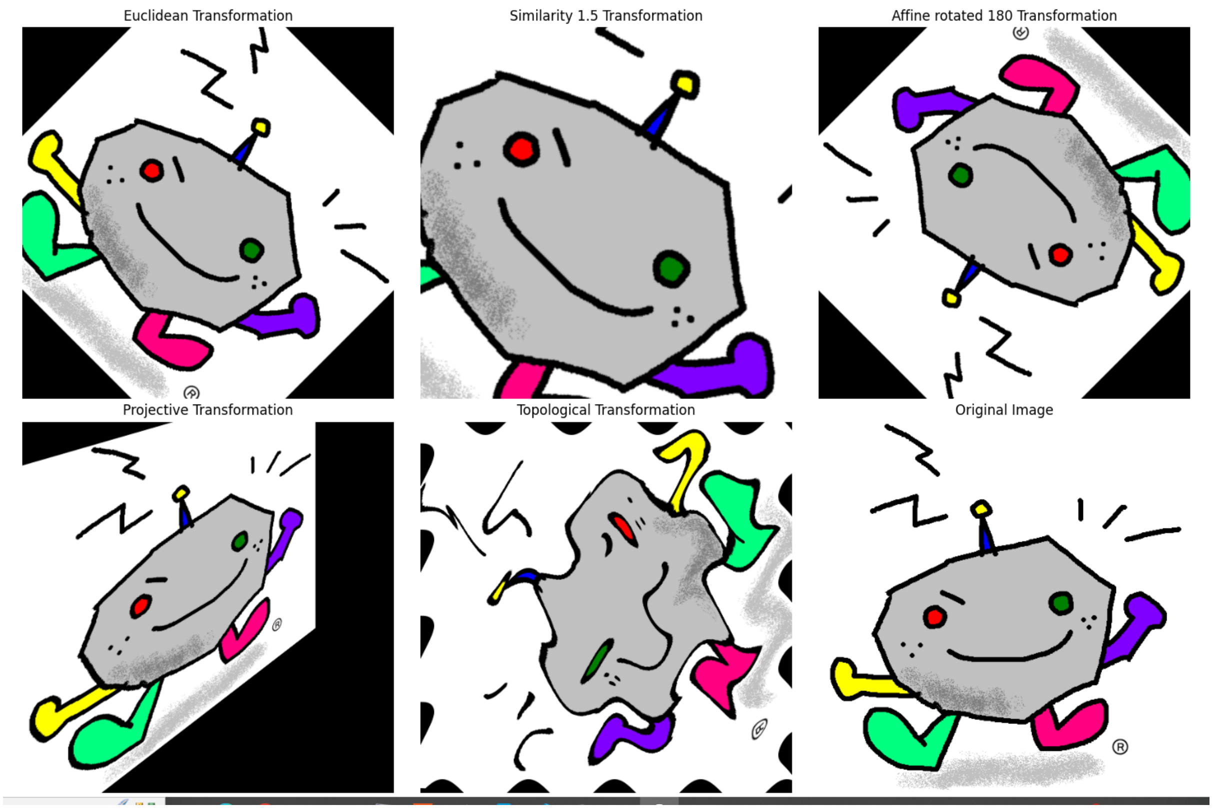
画像と空間の幾何学変換

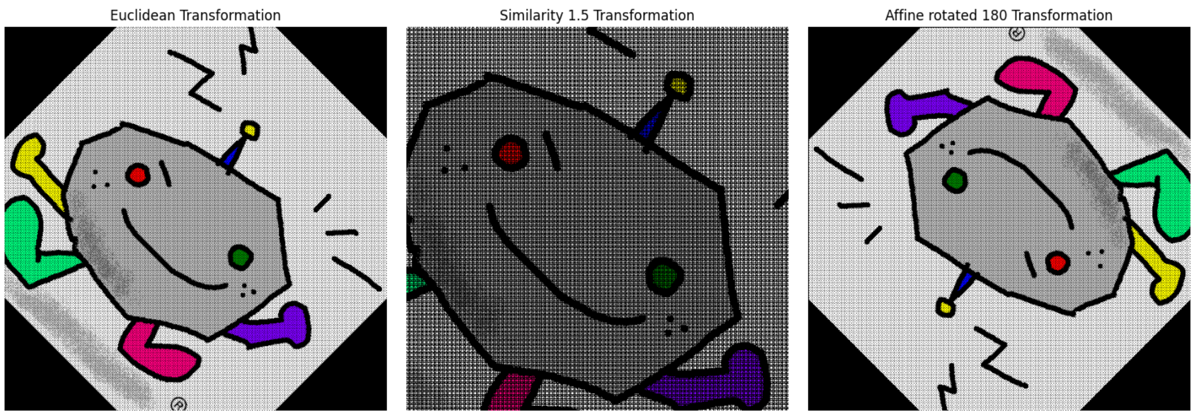
This time learned how to rotate, zoom, compress, invert images... And so on many operations, while using cv2 and the use of matrix calculation to realize. Learned in the picture binarization, a variety of methods to find the bipolar value, I think the OTSU method is the best!

```
import cv2
import numpy as np
import matplotlib.pyplot as plt

# Load an image
image = cv2.imread('images/kan.png')
# Get the image size
height, width = image.shape[:2]
# Define the transformation matrix for rotation and scaling
M = cv2.getRotationMatrix2D((width//2, height//2), -45, 1)
# Rotate by 45 degrees
euclidean_image  = cv2.warpAffine(image, M, (width, heigh
t))
# Define the similarity transformation matrix (scaling, rot
ation, translation)
M_similarity = cv2.getRotationMatrix2D((width // 2, height
// 2), 0, 1.5)
similarity_image = cv2.warpAffine(euclidean_image, M_simila
rity, (width, height))
rotated_image = cv2.rotate(euclidean_image, cv2.ROTATE_180)
# Define the source and destination points for projective t
ransformation
pts1 = np.float32([[50, 50], [200, 50], [50, 200], [200, 20
0]])
pts2 = np.float32([[50, 100], [200, 50], [50, 250], [200, 1
80]])
# Compute the homography matrix
M = cv2.getPerspectiveTransform(pts1, pts2)
projective_image = cv2.warpPerspective(image, M, (width, he
ight))
```

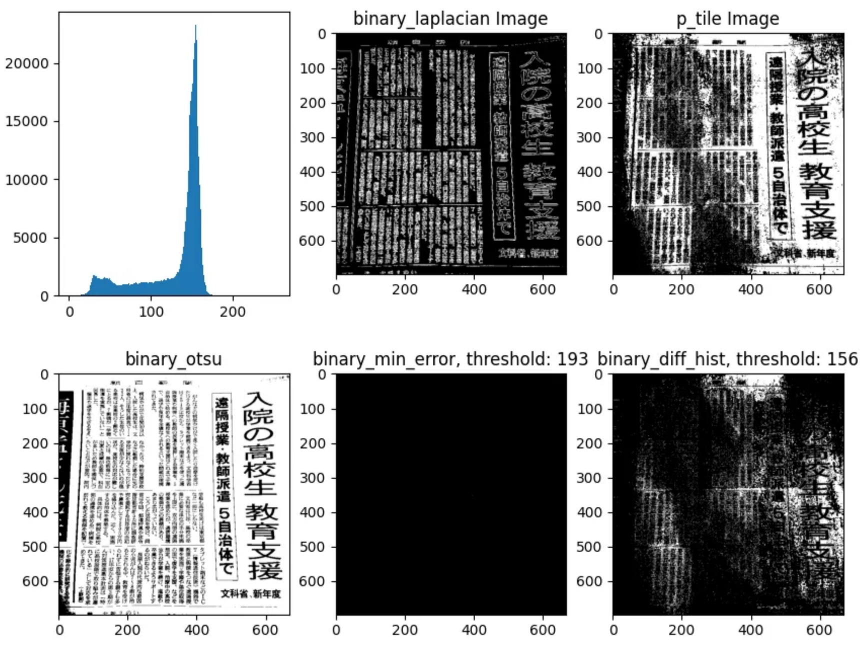
```
# Example of a simple topological transformation: image war
ping
map_x, map_y = np.indices((height, width), dtype=np.float3
2)
map_x = map_x + 20 * np.sin(map_y / 20)  # Apply a sine dis
tortion in the x-direction
map_y = map_y + 20 * np.cos(map_x / 20)  # Apply a cosine d
istortion in the y-direction
topological_image = cv2.remap(image, map_x, map_y, cv2.INTE
R_LINEAR)

fig, axs = plt.subplots(2, 3, figsize=(15, 10))
axs[0, 0].imshow(cv2.cvtColor(euclidean_image, cv2.COLOR_BG
R2RGB))
axs[0, 0].set_title('Euclidean Transformation')
axs[0, 1].imshow(cv2.cvtColor(similarity_image, cv2.COLOR_B
GR2RGB))
axs[0, 1].set_title('Similarity 1.5 Transformation')
axs[0, 2].imshow(cv2.cvtColor(rotated_image, cv2.COLOR_BGR2
RGB))
axs[0, 2].set_title('Affine rotated 180 Transformation')
axs[1, 0].imshow(cv2.cvtColor(projective_image, cv2.COLOR_B
GR2RGB))
axs[1, 0].set_title('Projective Transformation')
axs[1, 1].imshow(cv2.cvtColor(topological_image, cv2.COLOR_
BGR2RGB))
axs[1, 1].set_title('Topological Transformation')
axs[1, 2].imshow(cv2.cvtColor(image, cv2.COLOR_BGR2RGB))
axs[1, 2].set_title('Original Image')
for ax in axs.flat:
    ax.axis('off')
plt.tight_layout()
plt.show()
```

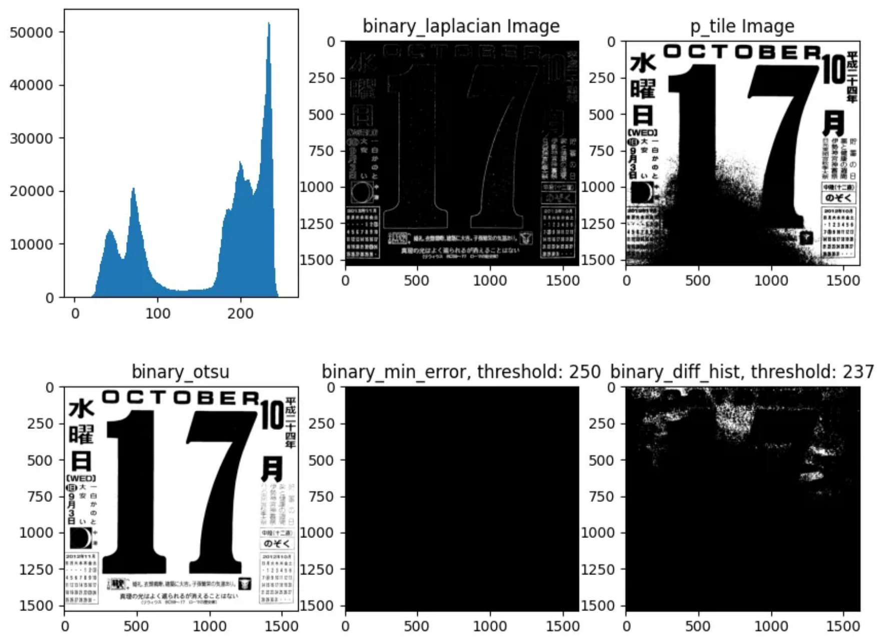

Euclidean Transformation
Similarity 1.5 Transformation
Affine rotated 180 Transformation
Projective Transformation
Topological Transformation
Original Image

```
import cv2
import numpy as np
import matplotlib.pyplot as plt

# Load an image
image = cv2.imread('images/kan.png')
image = cv2.imread('image.png')
height, width = image.shape[:2]
theta = -45
theta_rad = np.deg2rad(theta)
cos_theta = np.cos(theta_rad)
sin_theta = np.sin(theta_rad)
rotation_matrix = np.array([[cos_theta, -sin_theta], [sin_t
heta, cos_theta]])
center = np.array([width // 2, height // 2])
euclidean_image = np.zeros_like(image)
for y in range(height):
    for x in range(width):
        offset = np.array([x, y]) - center
        new_offset = np.dot(rotation_matrix, offset)
        new_x, new_y = new_offset + center
        new_x, new_y = int(round(new_x)), int(round(new_y))
        if 0 <= new_x < width and 0 <= new_y < height:
            euclidean_image[new_y, new_x] = image[y, x]
scale_x = 1.5
scale_y = 1.5
scaling_matrix = np.array([[scale_x, 0], [0, scale_y]])
similarity_image = np.zeros_like(euclidean_image)
for y in range(height):
    for x in range(width):
        offset = np.array([x, y]) - center
        new_offset = np.dot(scaling_matrix, offset)
        new_x, new_y = new_offset + cente
        new_x, new_y = int(round(new_x)), int(round(new_y))
        if 0 <= new_x < width and 0 <= new_y < height:
            similarity_image[new_y, new_x] = euclidean_imag
e[y, x]
rotation_matrix = np.array([[-1, 0], [0, -1]])
center = np.array([width // 2, height // 2])
rotated_image = np.zeros_like(euclidean_image)
for y in range(height):
    for x in range(width):
        offset = np.array([x, y]) - center
        new_offset = np.dot(rotation_matrix, offset)
        new_x, new_y = new_offset + center
        new_x, new_y = int(round(new_x)), int(round(new_y))
        if 0 <= new_x < width and 0 <= new_y < height:
            rotated_image[new_y, new_x] = euclidean_image
[y, x]

fig, axs = plt.subplots(2, 3, figsize=(15, 10))
axs[0, 0].imshow(cv2.cvtColor(euclidean_image, cv2.COLOR_BG
R2RGB))
axs[0, 0].set_title('Euclidean Transformation')
axs[0, 1].imshow(cv2.cvtColor(similarity_image, cv2.COLOR_B
GR2RGB))
axs[0, 1].set_title('Similarity 1.5 Transformation')
axs[0, 2].imshow(cv2.cvtColor(rotated_image, cv2.COLOR_BGR2
RGB))
axs[0, 2].set_title('Affine rotated 180 Transformation')
for ax in axs.flat:
    ax.axis('off')
plt.tight_layout()
plt.show()
```


Euclidean Transformation
Similarity 1.5 Transformation
Affine rotated 180 Transformation

```
import cv2
import matplotlib.pyplot as plt
import numpy as np
image_path = 'images/news.png'
image = cv2.imread(image_path, 1)
gray_image = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
def p_tile_method(image, p=50):
    flattened = image.flatten()
    threshold = np.percentile(flattened, p)
    _, binary_image = cv2.threshold(image, threshold, 255,
cv2.THRESH_BINARY)
    return binary_image
_, binary_otsu = cv2.threshold(gray_image, 0, 255, cv2.THRE
SH_BINARY + cv2.THRESH_OTSU)

def minimum_error_threshold(image):
    hist = cv2.calcHist([image], [0], None, [256], [0, 25
6]).flatten()
    hist = hist / hist.sum()
    bins = np.arange(256)
    total_mean = (bins * hist).sum()
    min_error = float('inf')
    best_threshold = 0
    for t in bins:
        w0 = hist[:t].sum()
        w1 = hist[t:].sum()
        if w0 == 0 or w1 == 0:
            continue
        mean0 = (bins[:t] * hist[:t]).sum() / w0
        mean1 = (bins[t:] * hist[t:]).sum() / w1
        error = w0 * (mean0 - total_mean)**2 + w1 * (mean1
- total_mean)**2
        if error < min_error:
            min_error = error
            best_threshold = t
    print(f"Best threshold: {best_threshold}")
    _, binary_image = cv2.threshold(image, best_threshold,
255, cv2.THRESH_BINARY)
    return binary_image, best_threshold
binary_min_error, binary_min_error_threshold = minimum_erro
r_threshold(gray_image)

def differential_histogram_method(image):
    # Calculate histogram
    hist = cv2.calcHist([image], [0], None, [256], [0, 25
6]).flatten()
    diff = np.diff(hist)
    # Find minimum index in the derivative (local minimum)
    threshold = np.argmin(diff)
    _, binary_image = cv2.threshold(image, threshold, 255,
cv2.THRESH_BINARY)
    return binary_image, threshold
binary_diff_hist, binary_diff_hist_threshold = differential
_histogram_method(gray_image)
def laplacian_histogram_method(image):
    # Apply Laplacian operator
    laplacian = cv2.Laplacian(image, cv2.CV_64F)
    laplacian = cv2.convertScaleAbs(laplacian)
    # Threshold using Otsu's method
    _, binary_image = cv2.threshold(laplacian, 0, 255, cv2.
THRESH_BINARY + cv2.THRESH_OTSU)
    return binary_image
binary_laplacian = laplacian_histogram_method(gray_image)
plt.figure(figsize=(10, 8))
plt.subplot(2, 3, 1)
plt.hist(gray_image.ravel(), 256, [0, 256])
plt.subplot(2, 3, 2)
plt.imshow(binary_laplacian, cmap='gray')
plt.title('binary_laplacian Image')
plt.subplot(2, 3, 3)
plt.imshow(p_tile_method(gray_image, 50), cmap='gray')
plt.title('p_tile Image')
plt.subplot(2, 3, 4)
plt.imshow(binary_otsu, cmap='gray')
plt.title('binary_otsu')
plt.subplot(2, 3, 5)
plt.imshow(binary_min_error, cmap='gray')
plt.title(f'binary_min_error, threshold: {binary_min_error_
threshold}')
plt.subplot(2, 3, 6)
plt.imshow(binary_diff_hist, cmap='gray')
plt.title(f'binary_diff_hist, threshold: {binary_diff_hist_
threshold}')
plt.show()
cv2.waitKey(0)
```


binary_laplacian Image
p_tile Image
binary_otsu
binary_min_error, threshold: 193
binary_diff_hist, threshold: 156


binary_laplacian Image
p_tile Image
binary_otsu
binary_min_error, threshold: 250
binary_diff_hist, threshold: 237