BCSE417P Lab Assignment 2

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By turning in this assignment, I agree and declare that all of this is my own work.

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

```
def distort_image(image_path, output_path):
    image = cv2.imread(image_path)
    h, w = image.shape[:2]

    # Define the original corner points of the image
    pts_original = np.float32([[0, 0], [w, 0], [w, h], [0, h]])

    # Perturb the points to create distortion
    pts_distorted = np.float32([[np.random.randint(0, 50), np.random.randint(0, 50)],
                                [w - np.random.randint(0, 50), np.random.randint(0, 50)],
                                [w - np.random.randint(0, 50), h - np.random.randint(0, 50)
                                [np.random.randint(0, 50), h - np.random.randint(0, 50)]])

    # Compute the perspective transformation matrix
    matrix = cv2.getPerspectiveTransform(pts_original, pts_distorted)

    # Apply the perspective transformation (distortion)
    distorted_image = cv2.warpPerspective(image, matrix, (w, h))

    # Save the distorted image
    cv2.imwrite(output_path, distorted_image)

    # Optionally display the images
    cv2.imshow('Original Image', image)
    cv2.imshow('Distorted Image', distorted_image)

    while True:
        if cv2.waitKey(1) & 0xFF == ord('q'):
            break
    cv2.destroyAllWindows()

# Example usage:
distort_image('../images/architecturalImage.webp', '../images/architecturalImageDistorted.v
```

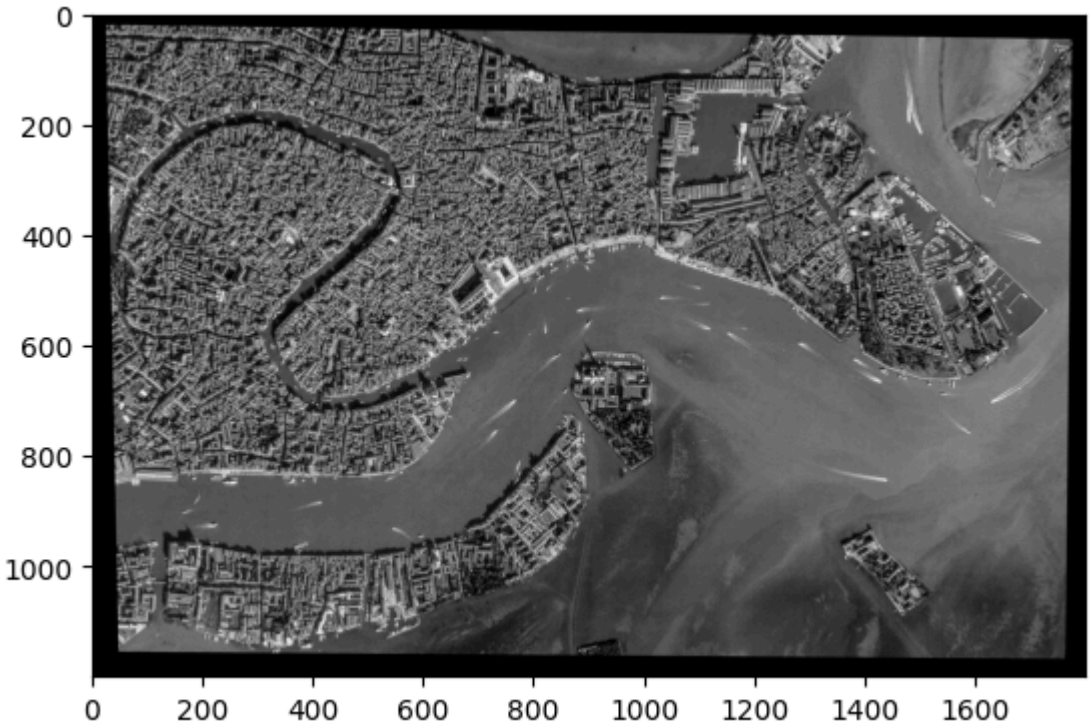
Assignment 2A

Task 1: Geometric Rectification of Satellite Imagery

Objective: Correct the geometric distortions in satellite images using bilinear interpolation.

```
distorted_image = cv2.imread('../images/satelliteDistorted.png', cv2.IMREAD_GRAYSCALE)
plt.imshow(distorted_image, cmap='gray')
```

```
<matplotlib.image.AxesImage at 0x7f6980b4ae60>
```




```
# Define method to get GCPs from the image
rectified_satellite_image = cv2.imread('../images/satellite.png', cv2.IMREAD_GRAYSCALE)
GCP_distorted = []
def get_GCPs(event, x, y, flags, param):
    if event == cv2.EVENT_LBUTTONDOWN:
        # On left mouse button click, append GCPs
        GCP_distorted.append((x, y))
        # Mark the selected point on the image
        cv2.circle(distorted_image, (x, y), 5, (0, 0, 255), -1)
        cv2.imshow('Distorted Image', distorted_image)
        print(f'GCP selected: {x}, {y}')

# Display the image and set the mouse callback
cv2.imshow('Distorted Image', distorted_image)
cv2.setMouseCallback('Distorted Image', get_GCPs)

# Wait until 'q' is pressed to close the window
while True:
    if cv2.waitKey(1) & 0xFF == ord('q'):
        break

cv2.destroyAllWindows()

print("Distorted GCPs: ", GCP_distorted)
```

```
GCP selected: 2, 4
GCP selected: 1, 1192
GCP selected: 1795, 1196
GCP selected: 1796, 7
Distorted GCPs:  [(2, 4), (1, 1192), (1795, 1196), (1796, 7)]
```

```python
# Define method to get GCPs from the image
GCP_rectified = []
def get_GCPs(event, x, y, flags, param):
    if event == cv2.EVENT_LBUTTONDOWN:
        # On left mouse button click, append GCPs
        GCP_rectified.append((x, y))
        # Mark the selected point on the image
        cv2.circle(distorted_image, (x, y), 5, (0, 0, 255), -1)
        cv2.imshow('Distorted Image', distorted_image)
        print(f'GCP selected: {x}, {y}')

# Display the image and set the mouse callback
cv2.imshow('Distorted Image', distorted_image)
cv2.setMouseCallback('Distorted Image', get_GCPs)

# Wait until 'q' is pressed to close the window
while True:
    if cv2.waitKey(1) & 0xFF == ord('q'):
        break

cv2.destroyAllWindows()

print("Rectified GCPs: ", GCP_rectified)
```

```
GCP selected: 28, 23
GCP selected: 48, 1156
GCP selected: 1758, 1170
GCP selected: 1769, 47
Rectified GCPs:  [(28, 23), (48, 1156), (1758, 1170), (1769, 47)]
```

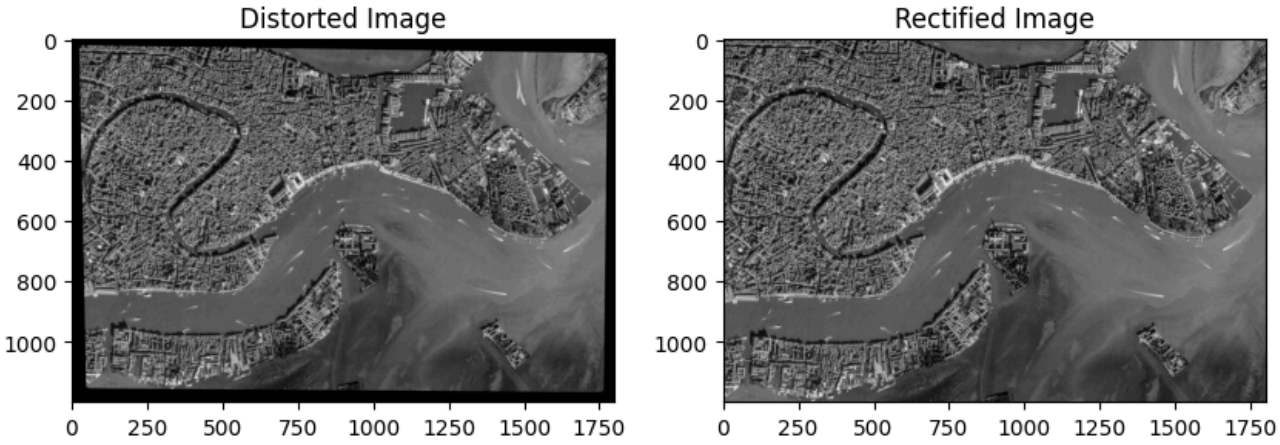
```python
GCP_distorted = np.array(GCP_distorted, dtype=np.float32)
GCP_rectified = np.array(GCP_rectified, dtype=np.float32)

# Calculate the transformation matrix
transformation_matrix = cv2.getPerspectiveTransform(GCP_distorted, GCP_rectified)
print("Transformation Matrix: ", transformation_matrix)
```

```
Transformation Matrix:  [[ 1.14130347e-01 -5.67475790e-02  2.18838743e+02]
 [ 7.30013313e-03  2.07686125e-01  1.36054572e+02]
 [ 3.04385207e-05 -1.97852126e-04  1.00000000e+00]]
```

```python
# Apply the perspective transformation
rectified_satelite_image = cv2.warpPerspective(distorted_image, transformation_matrix, (400
```

```python
plt.figure(figsize=(10, 5))
plt.subplot(1, 2, 1)
plt.title('Distorted Image')
plt.imshow(cv2.cvtColor(distorted_image, cv2.COLOR_BGR2RGB))

plt.subplot(1, 2, 2)
plt.title('Rectified Image')
plt.imshow(cv2.cvtColor(rectified_satellite_image, cv2.COLOR_BGR2RGB))
```

```
<matplotlib.image.AxesImage at 0x7f697bf5ec20>
```



Summary

The geometric rectification of a distorted satellite image was performed using OpenCV. First, four Ground Control Points (GCPs) were selected from both the distorted and rectified images. A perspective transformation matrix was computed using the GCPs, and bilinear interpolation was applied to resample pixel values and ensure smooth transitions. The transformation was executed using `cv2.warpPerspective()`.

Challenges:

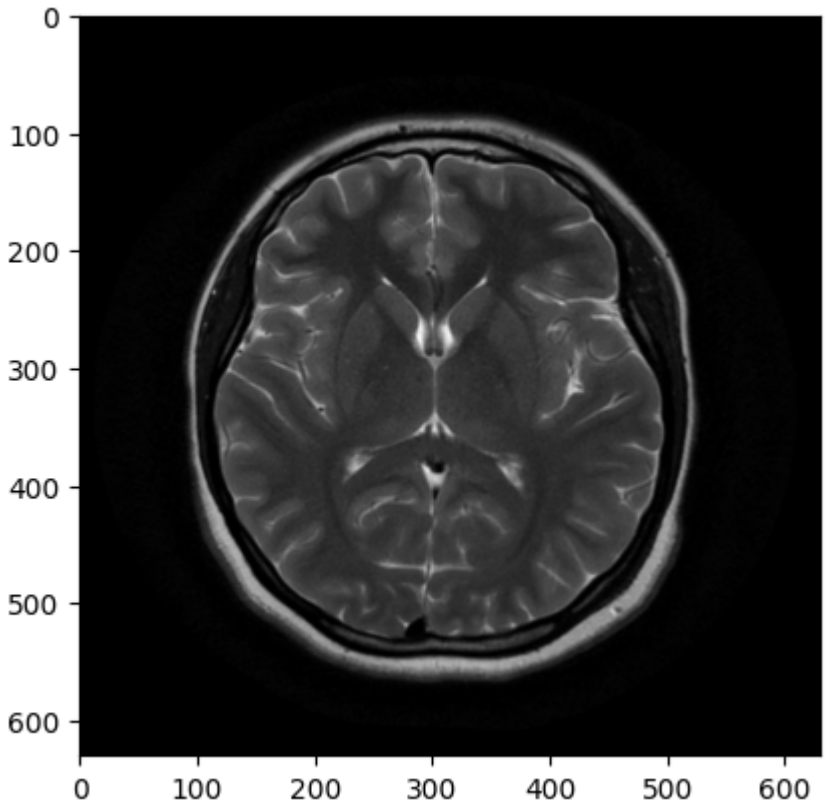
- Accurate GCP selection was crucial. Misaligned GCPs caused distortion in the rectified image.
- Ensuring that the rectified image dimensions matched the GCPs was important to prevent stretching.

Results: The process successfully corrected the geometric distortions, with the rectified image displaying improved spatial accuracy. The use of bilinear interpolation resulted in a smooth, natural-looking transformation.

Task 2: Medical Image Rectification

```
mri_image = cv2.imread('../images/MRIDistorted.jpeg', 0)
plt.imshow(mri_image, cmap='gray')
```

```
<matplotlib.image.AxesImage at 0x7f697ced2e90>
```




```
# Define method to get GCPs from the image
rectified_mri_image = cv2.imread('../images/MRI.jpeg', 0)
GCP_distorted = []
def get_GCPs(event, x, y, flags, param):
    if event == cv2.EVENT_LBUTTONDOWN:
        # On left mouse button click, append GCPs
        GCP_distorted.append((x, y))
        # Mark the selected point on the image
        cv2.circle(mri_image, (x, y), 5, (0, 0, 255), -1)
        cv2.imshow('Distorted Image', mri_image)
        print(f'GCP selected: {x}, {y}')

# Display the image and set the mouse callback
cv2.imshow('Distorted Image', mri_image)
cv2.setMouseCallback('Distorted Image', get_GCPs)

# Wait until 'q' is pressed to close the window
while True:
    if cv2.waitKey(1) & 0xFF == ord('q'):
        break

cv2.destroyAllWindows()

print("Distorted GCPs: ", GCP_distorted)
```

```
GCP selected: 195, 131
GCP selected: 185, 525
GCP selected: 452, 517
GCP selected: 419, 125
Distorted GCPs:  [(195, 131), (185, 525), (452, 517), (419, 125)]
```

```
# Define method to get GCPs from the image
GCP_rectified = []
def get_GCPs(event, x, y, flags, param):
    if event == cv2.EVENT_LBUTTONDOWN:
```

```
        # On left mouse button click, append GCPs
        GCP_rectified.append((x, y))
        # Mark the selected point on the image
        cv2.circle(mri_image, (x, y), 5, (0, 0, 255), -1)
        cv2.imshow('Distorted Image', mri_image)
        print(f'GCP selected: {x}, {y}')

# Display the image and set the mouse callback
cv2.imshow('Distorted Image', mri_image)
cv2.setMouseCallback('Distorted Image', get_GCPs)

# Wait until 'q' is pressed to close the window
while True:
    if cv2.waitKey(1) & 0xFF == ord('q'):
        break

cv2.destroyAllWindows()

print("Rectified GCPs: ", GCP_rectified)
```

```
GCP selected: 219, 137
GCP selected: 198, 502
GCP selected: 435, 486
GCP selected: 402, 143
Rectified GCPs:  [(219, 137), (198, 502), (435, 486), (402, 143)]
```

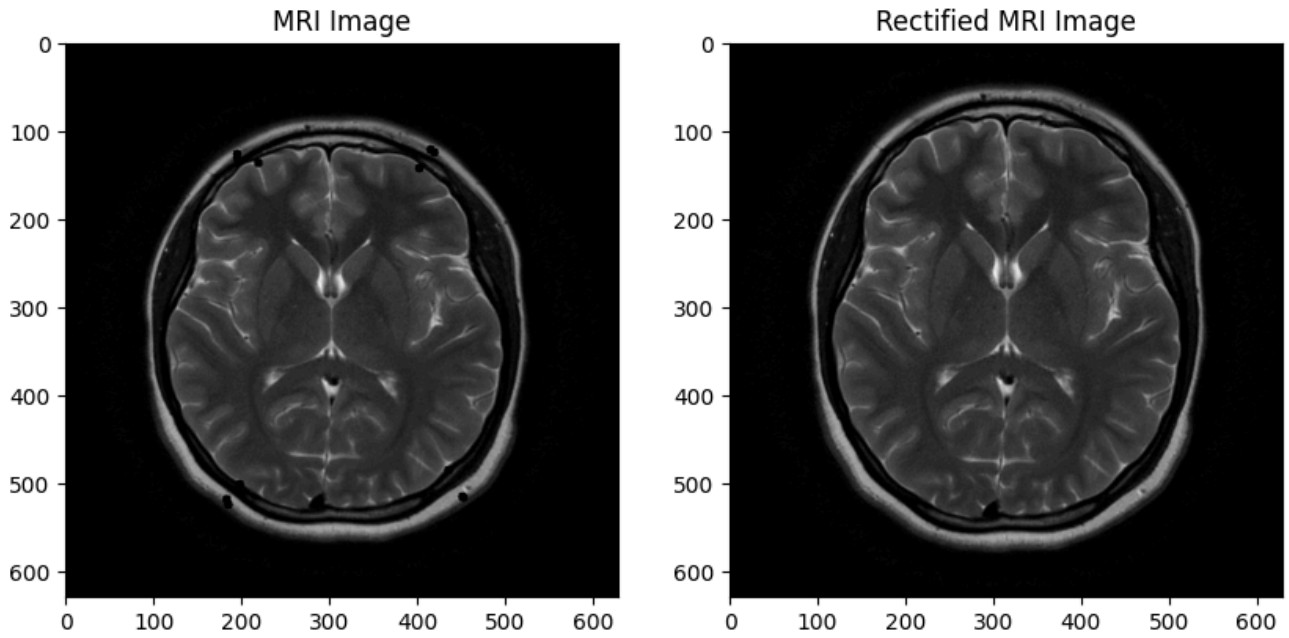
```
GCP_distorted = np.array(GCP_distorted, dtype=np.float32)
GCP_rectified = np.array(GCP_rectified, dtype=np.float32)

# Calculate the transformation matrix
transformation_matrix = cv2.getPerspectiveTransform(GCP_distorted, GCP_rectified)
print("Transformation Matrix: ", transformation_matrix)
```

```
Transformation Matrix:  [[-9.82914986e-01 -6.32446561e-02  2.81640972e+02]
 [-9.06889949e-01  2.87382739e-01  1.91605501e+02]
 [-3.10442846e-03 -1.61252077e-04  1.00000000e+00]]
```

```
# Apply the perspective transformation
rectified_mrii_image = cv2.warpPerspective(mri_image, transformation_matrix, (400, 400), fl
```

```
plt.figure(figsize=(10, 5))
plt.subplot(1, 2, 1)
plt.title('MRI Image')
plt.imshow(cv2.cvtColor(mri_image, cv2.COLOR_BGR2RGB))

plt.subplot(1, 2, 2)
plt.title('Rectified MRI Image')
plt.imshow(cv2.cvtColor(rectified_mri_image, cv2.COLOR_BGR2RGB))
```

```
<matplotlib.image.AxesImage at 0x7f697c353940>
```



MRI Image Rectification Summary

Process: The task involved rectifying distortions in an MRI image by aligning it with a reference anatomical model. First, key anatomical landmarks were identified as Ground Control Points (GCPs) in both the distorted MRI image and the reference model. A perspective transformation matrix was computed using these GCPs to align the MRI image with the reference. Bilinear interpolation was applied to resample the pixel values smoothly across the rectified image. The entire process was carried out using OpenCV functions such as `getPerspectiveTransform()` and `warpPerspective()`.

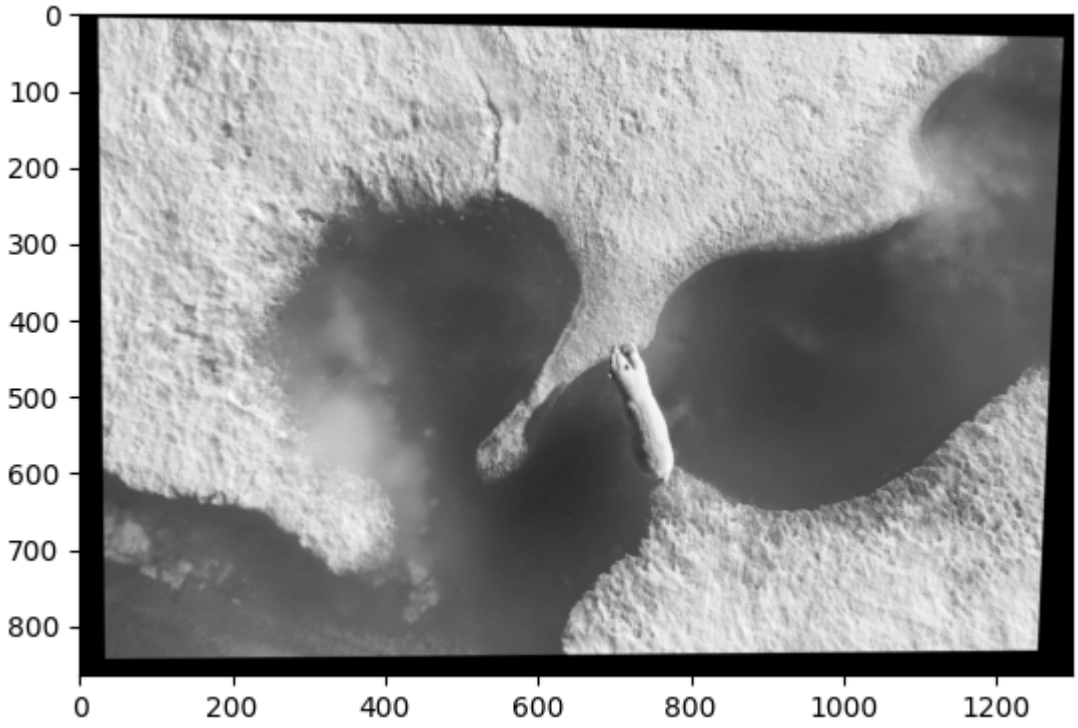
Results: The rectified MRI image showed significant improvement in spatial alignment when compared to the reference anatomical model. The use of bilinear interpolation ensured smooth pixel transitions, resulting in a more accurate and visually consistent image.

Issues Encountered: The main challenge was the accurate identification of corresponding GCPs between the distorted image and the reference model. Small deviations in GCP selection resulted in minor misalignment and distortion, emphasizing the importance of precise point selection for effective rectification.

Task 3: Drone Image rectification

```
drone_image = cv2.imread('../images/droneImageDistorted.jpg', 0)
plt.imshow(drone_image, cmap='gray')
```

```
<matplotlib.image.AxesImage at 0x7f697bbc6ad0>
```




```python
# Define method to get GCPs from the image
rectified_drone_image = cv2.imread('../images/droneImage.jpg', 0)
GCP_distorted = []
def get_GCPs(event, x, y, flags, param):
    if event == cv2.EVENT_LBUTTONDOWN:
        # On left mouse button click, append GCPs
        GCP_distorted.append((x, y))
        # Mark the selected point on the image
        cv2.circle(drone_image, (x, y), 5, (0, 0, 255), -1)
        cv2.imshow('Distorted Image', drone_image)
        print(f'GCP selected: {x}, {y}')

# Display the image and set the mouse callback
cv2.imshow('Distorted Image', drone_image)
cv2.setMouseCallback('Distorted Image', get_GCPs)

# Wait until 'q' is pressed to close the window
while True:
    if cv2.waitKey(1) & 0xFF == ord('q'):
        break

cv2.destroyAllWindows()

print("Distorted GCPs: ", GCP_distorted)
```

```
GCP selected: 25, 6
GCP selected: 35, 840
GCP selected: 1254, 836
GCP selected: 1287, 35
Distorted GCPs:  [(25, 6), (35, 840), (1254, 836), (1287, 35)]
```

```python
# Define method to get GCPs from the image
GCP_rectified = []
def get_GCPs(event, x, y, flags, param):
    if event == cv2.EVENT_LBUTTONDOWN:
        # On left mouse button click, append GCPs
        GCP_rectified.append((x, y))
```

```
        # Mark the selected point on the image
        cv2.circle(drone_image, (x, y), 5, (0, 0, 255), -1)
        cv2.imshow('Distorted Image', drone_image)
        print(f'GCP selected: {x}, {y}')

# Display the image and set the mouse callback
cv2.imshow('Distorted Image', drone_image)
cv2.setMouseCallback('Distorted Image', get_GCPs)

# Wait until 'q' is pressed to close the window
while True:
    if cv2.waitKey(1) & 0xFF == ord('q'):
        break

cv2.destroyAllWindows()

print("Rectified GCPs: ", GCP_rectified)
```

```
GCP selected: 497, 685
GCP selected: 251, 450
GCP selected: 936, 375
GCP selected: 1015, 604
Rectified GCPs:  [(497, 685), (251, 450), (936, 375), (1015, 604)]
```

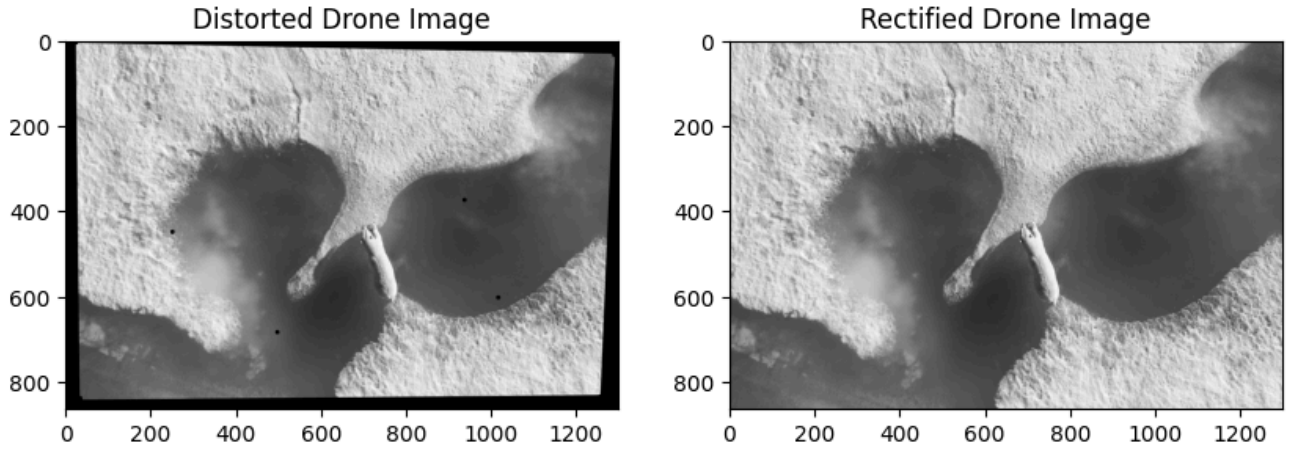
```
GCP_distorted = np.array(GCP_distorted, dtype=np.float32)
GCP_rectified = np.array(GCP_rectified, dtype=np.float32)

# Calculate the transformation matrix
transformation_matrix = cv2.getPerspectiveTransform(GCP_distorted, GCP_rectified)
print("Transformation Matrix: ", transformation_matrix)
```

```
Transformation Matrix:  [[ 4.65871727e-01 -3.78294336e-01  4.87358936e+02]
 [-2.65449880e-02 -4.20969780e-01  6.87825530e+02]
 [ 5.33902278e-05 -3.11002795e-04  1.00000000e+00]]
```

```
# Apply the perspective transformation
recified_drone_image = cv2.warpPerspective(drone_image, transformation_matrix, (400, 400),
```

```
plt.figure(figsize=(10, 5))
plt.subplot(1, 2, 1)
plt.title('Distorted Drone Image')
plt.imshow(cv2.cvtColor(drone_image, cv2.COLOR_BGR2RGB))

plt.subplot(1, 2, 2)
plt.title('Rectified Drone Image')
plt.imshow(cv2.cvtColor(rectified_drone_image, cv2.COLOR_BGR2RGB))
```

```
<matplotlib.image.AxesImage at 0x7f697b39d930>
```



Drone Image Rectification Report

Objective

The goal of this task was to correct geometric distortions in drone-captured images of an agricultural field using bilinear interpolation.

Process

1. **Image Import**: The distorted drone image was loaded into the image processing software.
2. **Control Points Identification**: Several control points were identified and marked on the distorted image, which corresponded to known field locations.
3. **Rectified Coordinates**: The corresponding coordinates of the control points were defined for the rectified image.
4. **Transformation Matrix**: A transformation matrix was applied to map the distorted image coordinates to the corrected ones.
5. **Bilinear Interpolation**: Bilinear interpolation was used to resample pixel values, ensuring smooth transitions between transformed points.
6. **Orthophoto Generation**: An orthophoto of the field was generated from the rectified image and compared with the original distorted image.

Results

The rectified image showed a significant reduction in geometric distortions, with the orthophoto providing a more accurate representation of the agricultural field.

Difficulties

- Identifying precise control points was challenging due to distortion.

- Slight loss of image quality was observed during resampling, but this was minimized by using bilinear interpolation.

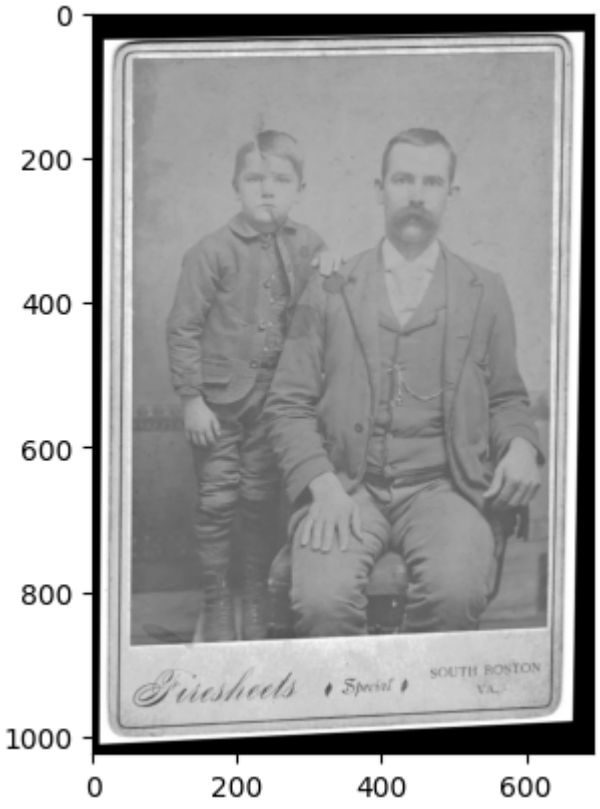
Conclusion

The rectification process successfully corrected the geometric distortions, yielding a more accurate orthophoto of the field.

Task 4: Historical Photo Restoration

```
historical_image = cv2.imread('../images/HistoricalPhotoDistorted.webp', cv2.IMREAD_GRAYSCA
plt.imshow(historical_image, cmap='gray')
```

```
<matplotlib.image.AxesImage at 0x7f6970131960>
```




```
# Define method to get GCPs from the image
rectified_historical_image = cv2.imread('../images/historicalPhoto.webp', 0)
GCP_distorted = []
def get_GCPs(event, x, y, flags, param):
    if event == cv2.EVENT_LBUTTONDOWN:
        # On left mouse button click, append GCPs
        GCP_distorted.append((x, y))
        # Mark the selected point on the image
        cv2.circle(historical_image, (x, y), 5, (0, 0, 255), -1)
        cv2.imshow('Distorted Image', historical_image)
        print(f'GCP selected: {x}, {y}')

# Display the image and set the mouse callback
cv2.imshow('Distorted Image', historical_image)
cv2.setMouseCallback('Distorted Image', get_GCPs)
```

```
# Wait until 'q' is pressed to close the window
while True:
    if cv2.waitKey(1) & 0xFF == ord('q'):
        break

cv2.destroyAllWindows()

print("Distorted GCPs: ", GCP_distorted)
```

```
GCP selected: 2, 4
GCP selected: 2, 1020
GCP selected: 687, 1020
GCP selected: 688, 3
Distorted GCPs:  [(2, 4), (2, 1020), (687, 1020), (688, 3)]
```

```
# Define method to get GCPs from the image
GCP_rectified = []
def get_GCPs(event, x, y, flags, param):
    if event == cv2.EVENT_LBUTTONDOWN:
        # On left mouse button click, append GCPs
        GCP_rectified.append((x, y))
        # Mark the selected point on the image
        cv2.circle(historical_image, (x, y), 5, (0, 0, 255), -1)
        cv2.imshow('Distorted Image', historical_image)
        print(f'GCP selected: {x}, {y}')

# Display the image and set the mouse callback
cv2.imshow('Distorted Image', historical_image)
cv2.setMouseCallback('Distorted Image', get_GCPs)

# Wait until 'q' is pressed to close the window
while True:
    if cv2.waitKey(1) & 0xFF == ord('q'):
        break

cv2.destroyAllWindows()

print("Rectified GCPs: ", GCP_rectified)
```

```
GCP selected: 17, 39
GCP selected: 11, 1008
GCP selected: 663, 978
GCP selected: 679, 27
Rectified GCPs:  [(17, 39), (11, 1008), (663, 978), (679, 27)]
```

```
GCP_distorted = np.array(GCP_distorted, dtype=np.float32)
GCP_rectified = np.array(GCP_rectified, dtype=np.float32)

# Calculate the transformation matrix
transformation_matrix = cv2.getPerspectiveTransform(GCP_distorted, GCP_rectified)
print("Transformation Matrix: ", transformation_matrix)

# Apply the perspective transformation
recified_historical_image = cv2.warpPerspective(historical_image, transformation_matrix, (4
```

```
Transformation Matrix:  [[ 9.85341753e-01 -5.75097935e-03  1.50542933e+01]
 [-1.52793771e-02  9.68074437e-01  3.51627871e+01]
 [ 2.98049091e-05  1.41107102e-05  1.00000000e+00]]
```

```
plt.figure(figsize=(10, 5))
plt.subplot(1, 2, 1)
```

```
plt.title('Distorted Historical Image')
plt.imshow(cv2.cvtColor(historical_image, cv2.COLOR_BGR2RGB))

plt.subplot(1, 2, 2)
plt.title('Rectified Historical Image')
plt.imshow(cv2.cvtColor(rectified_historical_image, cv2.COLOR_BGR2RGB))
```

```
<matplotlib.image.AxesImage at 0x7f69607a9270>
```

Photograph Restoration Report

Objective

The task aimed to rectify and restore old, distorted photographs using bilinear interpolation.

Process

1. **Image Import**: The scanned old photograph was imported into the image processing software for analysis and restoration.
2. **Key Points Identification**: Key points on the distorted photograph were identified and marked. These points represented prominent features in the image.
3. **Reference Coordinates**: Corresponding coordinates were obtained from a reference image or known dimensions of the original photograph.
4. **Transformation Matrix**: A transformation matrix was applied to align the distorted photograph with the reference coordinates.

5. **Bilinear Interpolation**: Bilinear interpolation was used to resample pixel values, ensuring smooth transitions across the restored image.

6. **Comparison**: The rectified photograph was compared with both the original scanned image and the reference image to evaluate the restoration quality.

Results

The restoration process improved the alignment and reduced distortions, closely matching the original dimensions of the photograph.

Challenges

- Accurately identifying key points on heavily distorted areas was difficult.
- Some minor loss of detail occurred during resampling, though the bilinear interpolation technique minimized this effect.

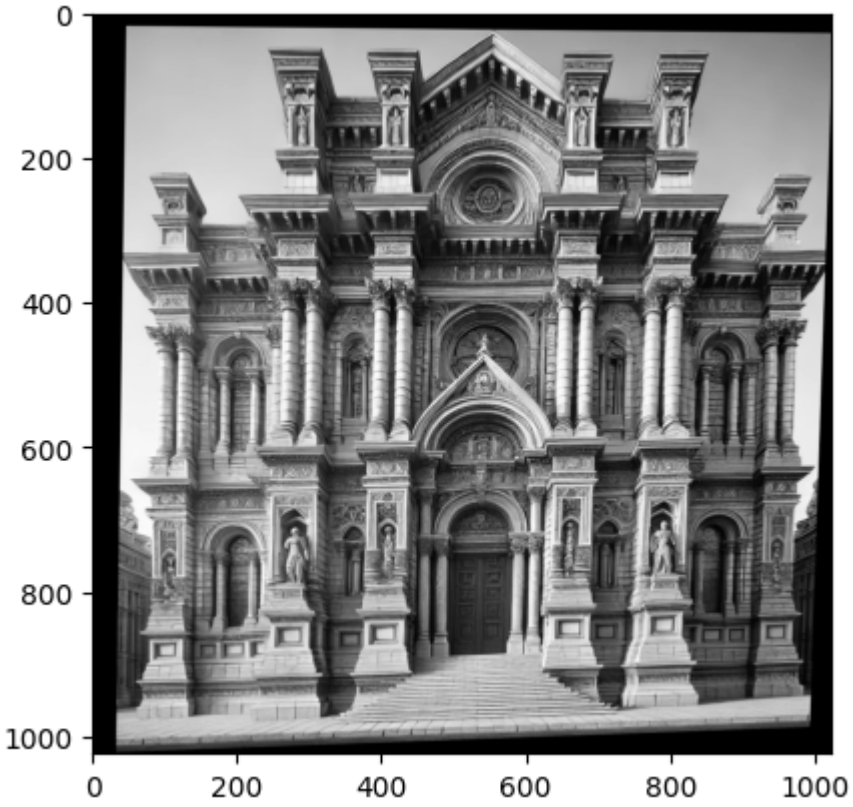
Conclusion

The photograph was successfully rectified, with distortions corrected and the restored image closely resembling the original undistorted photograph.

Task 5: Architectural Image Rectification

```
architectural_image = cv2.imread('../images/architecturalImageDistorted.webp', cv2.IMREAD_C
plt.imshow(architectural_image, cmap='gray')
```

```
<matplotlib.image.AxesImage at 0x7f6960647640>
```




```
# Define method to get GCPs from the image
rectified_architectural_image = cv2.imread('../images/architecturalImage.webp', 0)
GCP_distorted = []
def get_GCPs(event, x, y, flags, param):
    if event == cv2.EVENT_LBUTTONDOWN:
        # On left mouse button click, append GCPs
        GCP_distorted.append((x, y))
        # Mark the selected point on the image
        cv2.circle(architectural_image, (x, y), 5, (0, 0, 255), -1)
        cv2.imshow('Distorted Image', architectural_image)
        print(f'GCP selected: {x}, {y}')

# Display the image and set the mouse callback
cv2.imshow('Distorted Image', architectural_image)
cv2.setMouseCallback('Distorted Image', get_GCPs)

# Wait until 'q' is pressed to close the window
while True:
    if cv2.waitKey(1) & 0xFF == ord('q'):
        break

cv2.destroyAllWindows()

print("Distorted GCPs: ", GCP_distorted)
```

```
GCP selected: 5, 6
GCP selected: 2, 1021
GCP selected: 1020, 1017
GCP selected: 1019, 6
Distorted GCPs:  [(5, 6), (2, 1021), (1020, 1017), (1019, 6)]
```

```
# Define method to get GCPs from the image
GCP_rectified = []
def get_GCPs(event, x, y, flags, param):
    if event == cv2.EVENT_LBUTTONDOWN:
```

```
        # On left mouse button click, append GCPs
        GCP_rectified.append((x, y))
        # Mark the selected point on the image
        cv2.circle(architectural_image, (x, y), 5, (0, 0, 255), -1)
        cv2.imshow('Distorted Image', architectural_image)
        print(f'GCP selected: {x}, {y}')

# Display the image and set the mouse callback
cv2.imshow('Distorted Image', architectural_image)
cv2.setMouseCallback('Distorted Image', get_GCPs)

# Wait until 'q' is pressed to close the window
while True:
    if cv2.waitKey(1) & 0xFF == ord('q'):
        break

cv2.destroyAllWindows()

print("Rectified GCPs: ", GCP_rectified)
```

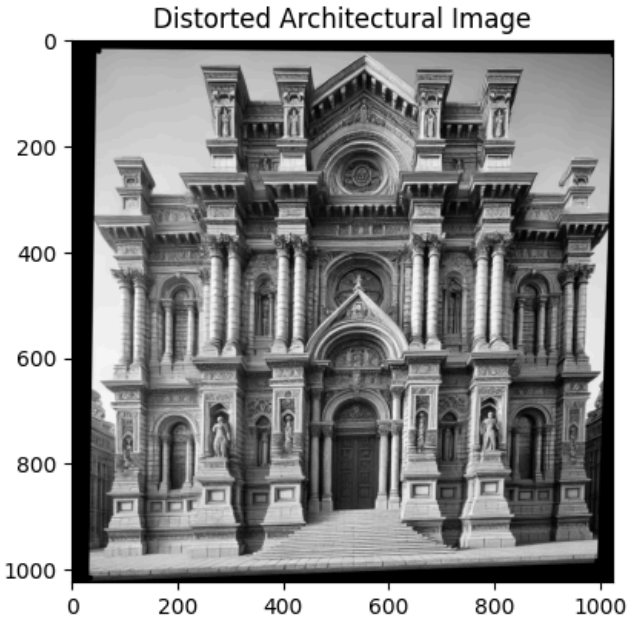
```
GCP selected: 51, 23
GCP selected: 35, 1016
GCP selected: 991, 985
GCP selected: 1022, 30
Rectified GCPs:  [(51, 23), (35, 1016), (991, 985), (1022, 30)]
```

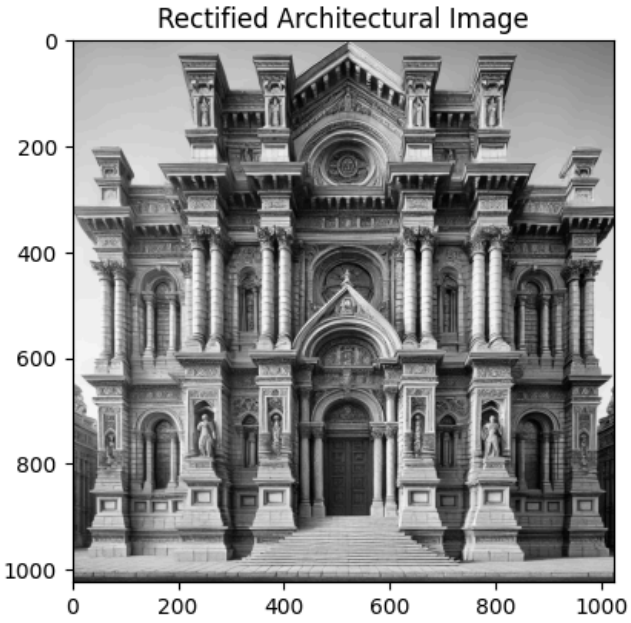
```
GCP_distorted = np.array(GCP_distorted, dtype=np.float32)
GCP_rectified = np.array(GCP_rectified, dtype=np.float32)

# Calculate the transformation matrix
transformation_matrix = cv2.getPerspectiveTransform(GCP_distorted, GCP_rectified)
print("Transformation Matrix: ", transformation_matrix)

# Apply the perspective transformation
recified_historical_image = cv2.warpPerspective(architectural_image, transformation_matrix,
```

```
Transformation Matrix:  [[ 9.93369143e-01 -1.31982746e-02  4.50925754e+01]
 [ 6.96771949e-03  9.93643836e-01  1.99832130e+01]
 [ 3.47336272e-05  1.67772876e-05  1.00000000e+00]]
```

```
plt.figure(figsize=(10, 5))
plt.subplot(1, 2, 1)
plt.title('Distorted Architectural Image')
plt.imshow(cv2.cvtColor(architectural_image, cv2.COLOR_BGR2RGB))

plt.subplot(1, 2, 2)
plt.title('Rectified Architectural Image')
plt.imshow(cv2.cvtColor(rectified_architectural_image, cv2.COLOR_BGR2RGB))
```

```
<matplotlib.image.AxesImage at 0x7f69605e1000>
```





Architectural Image Rectification Report

Objective

The objective of this task was to rectify perspective distortions in architectural images using bilinear interpolation.

Process

1. **Image Import**: The distorted architectural image was imported into the image processing software.
2. **Key Points Identification**: Key points on the distorted image were identified and marked, corresponding to known dimensions of the building's structure (e.g., corners of windows, edges of columns).
3. **Reference Coordinates**: The corresponding coordinates for these key points were defined in the rectified image, based on the building’s known dimensions.
4. **Transformation Matrix**: A transformation matrix was computed to align the distorted image with the correct perspective of the building.
5. **Bilinear Interpolation**: Bilinear interpolation was applied to resample the pixel values, ensuring that the transformation was smooth and free from pixelation.
6. **Comparison**: The rectified image was compared with the original distorted image to evaluate the correction and observe improvements in the architectural proportions.

Results

The rectification process successfully corrected the perspective distortions, resulting in a more accurate portrayal of the building's architectural features. The lines and edges of the structure appeared straight, and the overall proportions were restored to reflect the building's real-world dimensions.

Challenges

- It was challenging to accurately identify key points on highly distorted parts of the image.
- Some minor artifacts were introduced during resampling, but these were minimized using bilinear interpolation.

Conclusion

The image rectification process effectively corrected the perspective distortions, and the final result accurately represented the architectural structure with improved clarity and proportions.