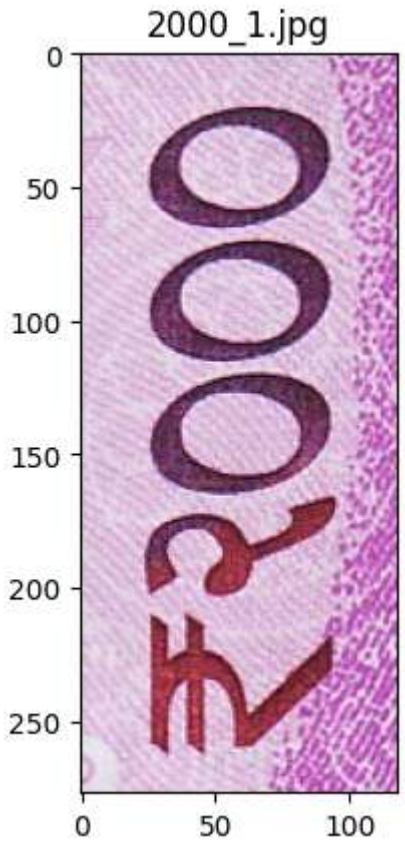
```
import cv2
import numpy as np
from skimage.metrics import structural_similarity as ssim
import matplotlib.pyplot as plt
import os
import pandas as pd


from google.colab import drive
drive.mount('/content/MyDrive')
```

```
Drive already mounted at /content/MyDrive; to attempt to forcibly remount, call drive
```

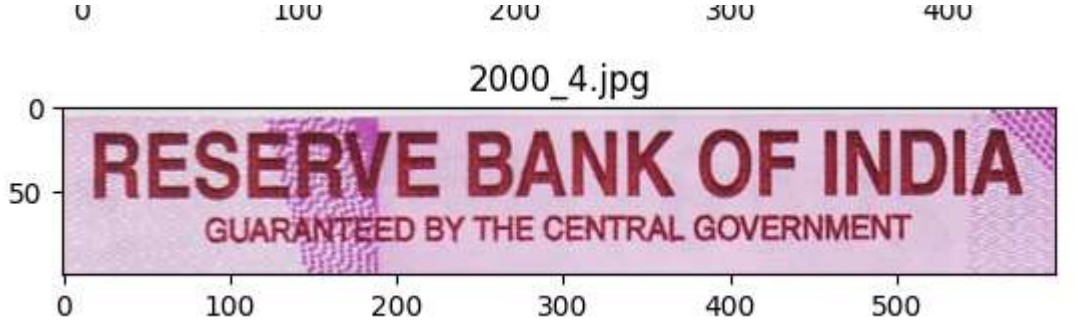
```
folder_path = "/content/MyDrive/MyDrive/Dataset/2000_Features/"


img = cv2.imread('/content/2000_s1.jpg')
plt.figure(figsize=(5, 5))
plt.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2RGB))
plt.axis('off')
plt.tight_layout()
plt.show()
```

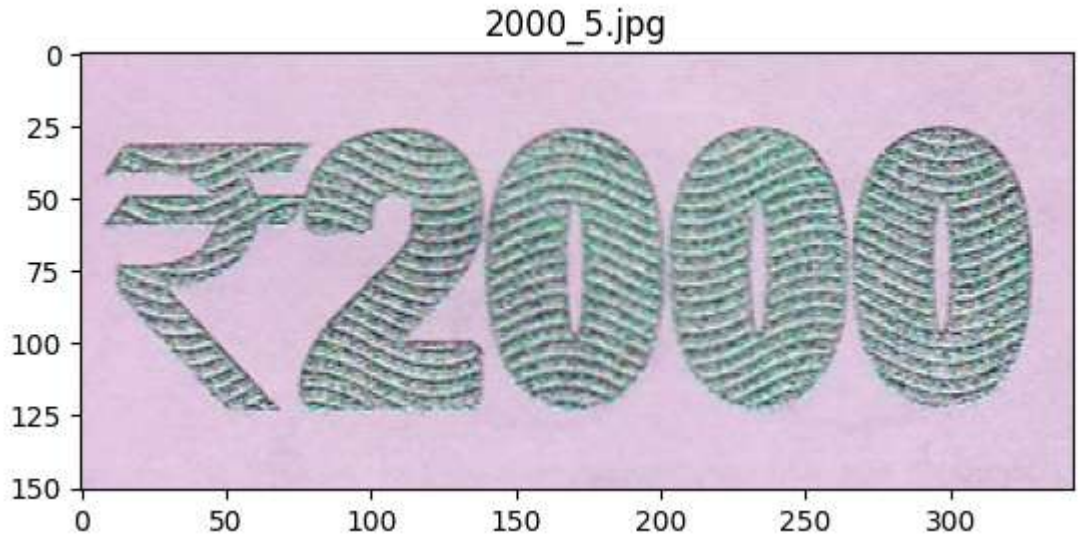

```
for filename in os.listdir(folder_path):
    image_path = os.path.join(folder_path, filename)
    try:
        img = cv2.imread(image_path)
        plt.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2RGB))
        plt.title(filename)
        plt.show()
    except Exception as e:
        print(f"Error processing image {filename}: {e}")
```

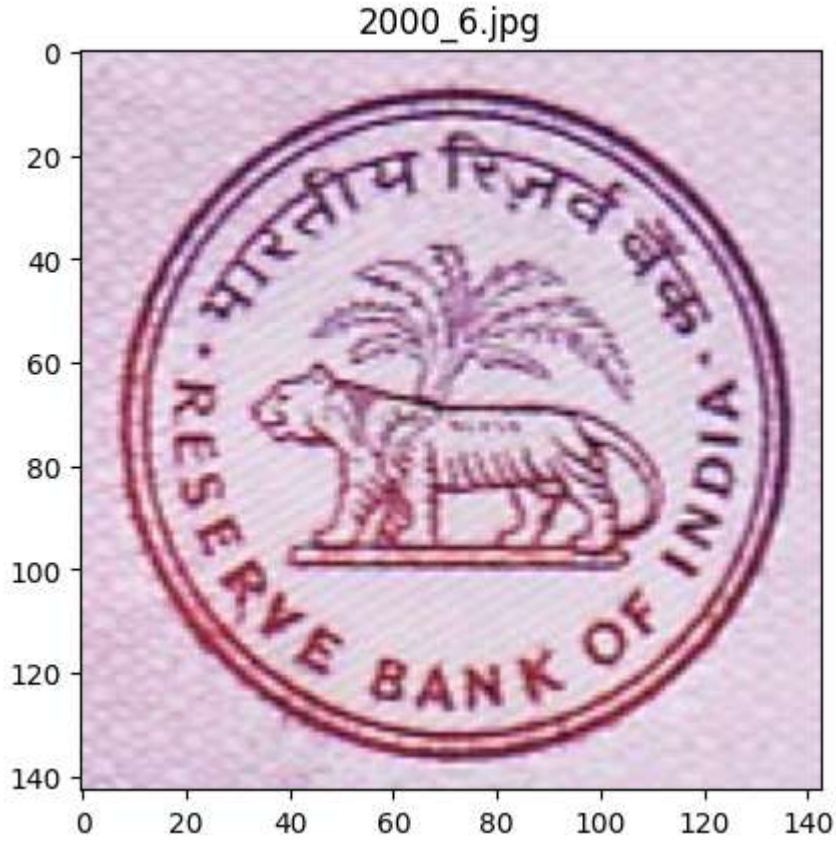

2000_1.jpg
2000


2000_2.jpg
सत्यमेव जयते

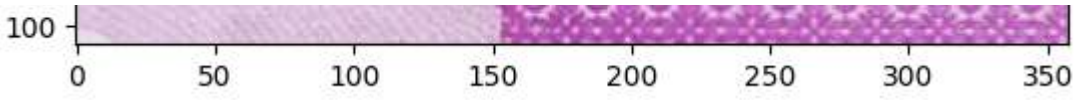

2000_3.jpg
भारतीय रिज़र्व बैंक
केन्द्रीय सरकार द्वारा प्रत्याभूत


2000_4.jpg
RESERVE BANK OF INDIA
GUARANTEED BY THE CENTRAL GOVERNMENT


2000_5.jpg
₹2000


2000_6.jpg
भारतीय रिज़र्व बैंक
RESERVE BANK OF INDIA


2000_7.jpg
दो हज़ार रुपये


100
0
50
100
150
200
250
300
350

CALCULATING SSIM SCORE FOR TWO IMAGES

```
def calculateSSIM(template_img, query_img):
    min_w = min(template_img.shape[1], query_img.shape[1])
    min_h = min(template_img.shape[0], query_img.shape[0])

    # Resizing the two images so that both have the same dimensions
    img1 = cv2.resize(template_img, (min_w, min_h))
    img2 = cv2.resize(query_img, (min_w, min_h))

    # Conversion to grayscale
    img1 = cv2.cvtColor(img1, cv2.COLOR_BGR2GRAY)
    img2 = cv2.cvtColor(img2, cv2.COLOR_BGR2GRAY)

    # Compute SSIM score
    score = ssim(img1, img2)
    return score


img1=cv2.imread('/content/2000_s1.jpg')
img2=cv2.imread('/content/2000_s2.jpg')
calculateSSIM(img1,img2)
```

```
0.263023832757299
```

CALCULATING ORB MATCHES FOR TWO IMAGES

```
def computeORB(template_img, query_img):
    # Initialize ORB detector
    orb = cv2.ORB_create(
        nfeatures=700,
        scaleFactor=1.2,
        nlevels=8,
        edgeThreshold=15
    )

    # Detect keypoints and descriptors
    kpts1, descs1 = orb.detectAndCompute(template_img, None)
    kpts2, descs2 = orb.detectAndCompute(query_img, None)

    # Brute Force Matcher
    bf = cv2.BFMatcher(cv2.NORM_HAMMING, crossCheck=True)
    matches = bf.match(descs1, descs2)
    dmatches = sorted(matches, key=lambda x: x.distance)

    # Homography to identify template location in the query image
    src_pts = np.float32([kpts1[m.queryIdx].pt for m in dmatches]).reshape(-1, 1, 2)
    dst_pts = np.float32([kpts2[m.trainIdx].pt for m in dmatches]).reshape(-1, 1, 2)

    M, mask = cv2.findHomography(src_pts, dst_pts, cv2.RANSAC, 5.0)
    h, w = template_img.shape[:2]
    pts = np.float32([[0, 0], [0, h - 1], [w - 1, h - 1], [w - 1, 0]]).reshape(-1, 1, 2)
```

```
    dst = cv2.perspectiveTransform(pts, M) if M is not None else None

    return dst, dst_pts, kpts1, kpts2, dmatches


img1=cv2.imread('/content/2000_s1.jpg')
img2=cv2.imread('/content/2000_s2.jpg')
computeORB(img1,img2)
```

```
          < cv2.DMatch 0x7bc539400350>,
          < cv2.DMatch 0x7bc539400dd0>,
          < cv2.DMatch 0x7bc539400910>,
          < cv2.DMatch 0x7bc539556e50>,
          < cv2.DMatch 0x7bc539557d90>,
          < cv2.DMatch 0x7bc539557970>,
          < cv2.DMatch 0x7bc539557d10>,
          < cv2.DMatch 0x7bc5395570f0>,
          < cv2.DMatch 0x7bc539400c10>])
```

PROCESSING IMAGES

```
def process_images(currency_img_path, emblem_folder_path):
    # Load the currency note
    currency_img = cv2.imread(currency_img_path)

    # Load emblem templates from the folder
    emblem_images = [cv2.imread(os.path.join(emblem_folder_path, img))
                     for img in os.listdir(emblem_folder_path) if img.endswith('.jpg')]

    # Results
    best_ssim = 0
    best_match = None
    orb_detected = False

    for idx, emblem in enumerate(emblem_images):
        print(f"Analyzing template {idx + 1}...")

        # SSIM Analysis
        ssim_score = calculateSSIM(emblem, currency_img)
        print(f"SSIM Score: {ssim_score}")

        # ORB Analysis
        dst, dst_pts, kpts1, kpts2, dmatches = computeORB(emblem, currency_img)
        print(f"ORB Matches Found: {len(dmatches)}")

        if dst is not None:
            orb_detected = True

            # Draw matches for visualization
            match_img = cv2.drawMatches(emblem, kpts1, currency_img, kpts2, dmatches[:10]
            plt.figure(figsize=(12, 6))
            plt.imshow(match_img)
            plt.title(f"Feature {idx + 1} Matches")
            plt.show()

        # Update best match if SSIM score improves
        if ssim_score > best_ssim:
            best_ssim = ssim_score
            best_match = idx

    print(f"Best Match: Feature {best_match + 1} with SSIM {best_ssim}")
    if orb_detected:
        print("ORB detected the feature successfully.")
```

```
        else:
            print("ORB failed to detect the feature.")
```

FEATURE 1 - ₹2000 Symbol

```
# Input paths
currency_img_path = "/content/2000_s9.jpg"
folder_path = "/content/MyDrive/MyDrive/Dataset/2000_Features Dataset/Feature 1"

# Call the process_images function
process_images(currency_img_path, folder_path)
```

```
Analyzing template 1...
SSIM Score: 0.11302203031756411
ORB Matches Found: 111
```

Feature 1 Matches


```
Analyzing template 2...
SSIM Score: 0.11587128455468944
ORB Matches Found: 96
```

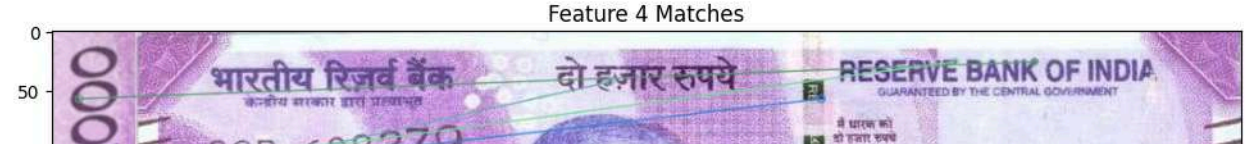
Feature 2 Matches


```
Analyzing template 3...
SSIM Score: 0.11393102018117116
ORB Matches Found: 104
```

Feature 3 Matches

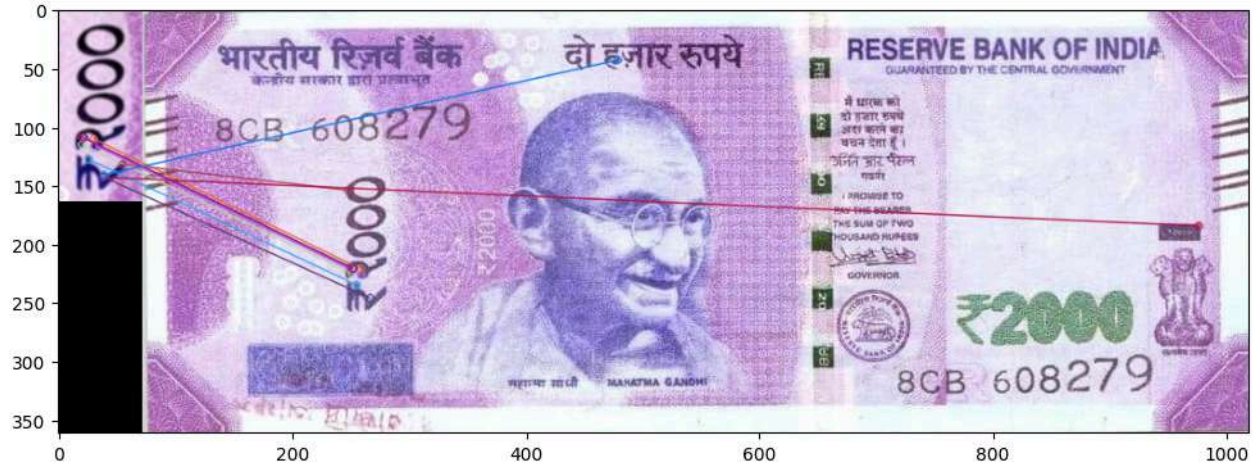

```
Analyzing template 4...
SSIM Score: 0.10518573243762405
ORB Matches Found: 95
```

Feature 4 Matches



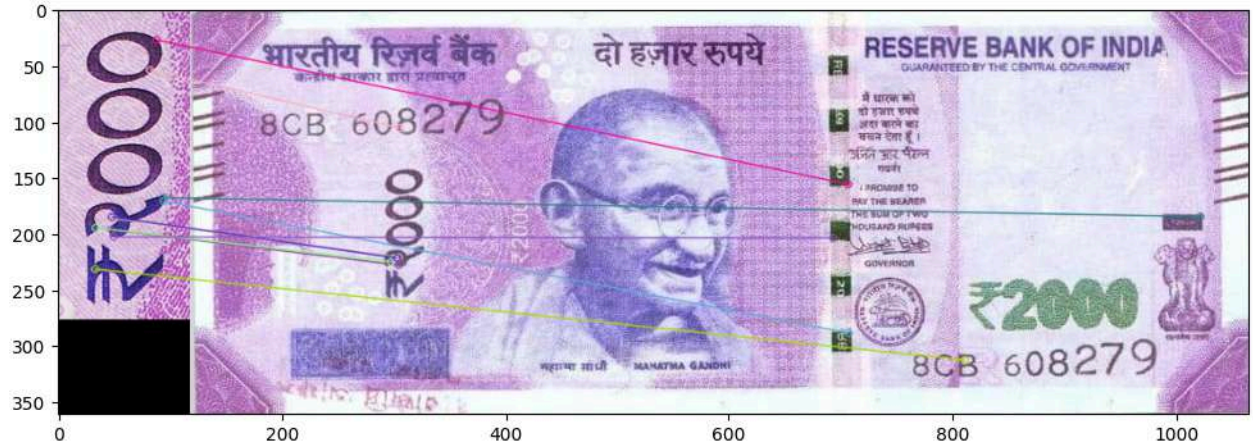
```
Analyzing template 5...
SSIM Score: 0.08601460102520508
ORB Matches Found: 124
```

Feature 5 Matches




```
Analyzing template 6...
SSIM Score: 0.07476597769929359
ORB Matches Found: 170
```

Feature 6 Matches



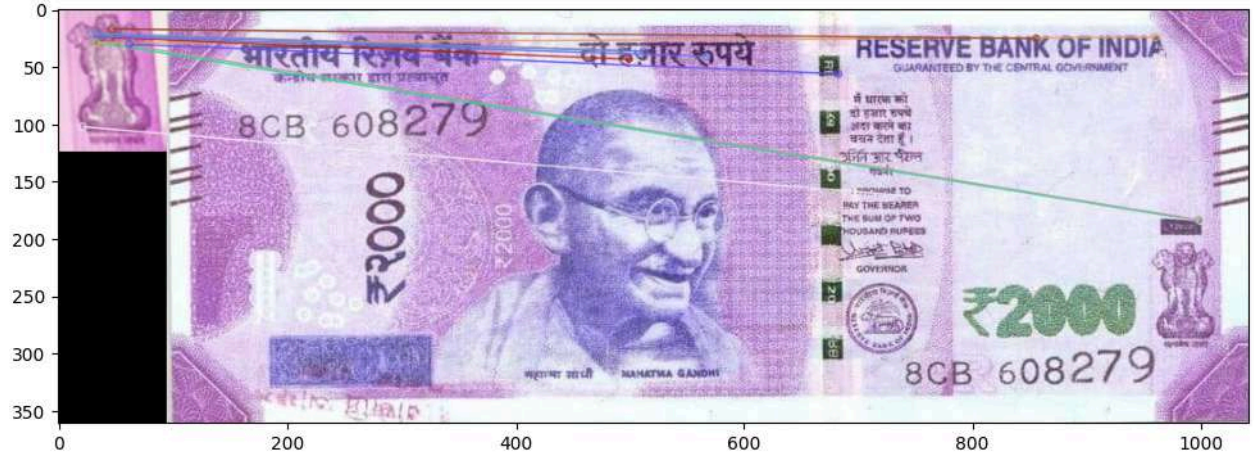

```
Best Match: Feature 2 with SSIM 0.11587128455468944
ORB detected the feature successfully.
```

FEATURE 2 - Indian Emblem

```
# Input paths
currency_img_path = "/content/2000_s9.jpg"  # Update with the actual currency note file
emblem_folder_path = "/content/MyDrive/MyDrive/Dataset/2000_Features Dataset/Feature 2"

# Call the process_images function
process_images(currency_img_path, emblem_folder_path)
```

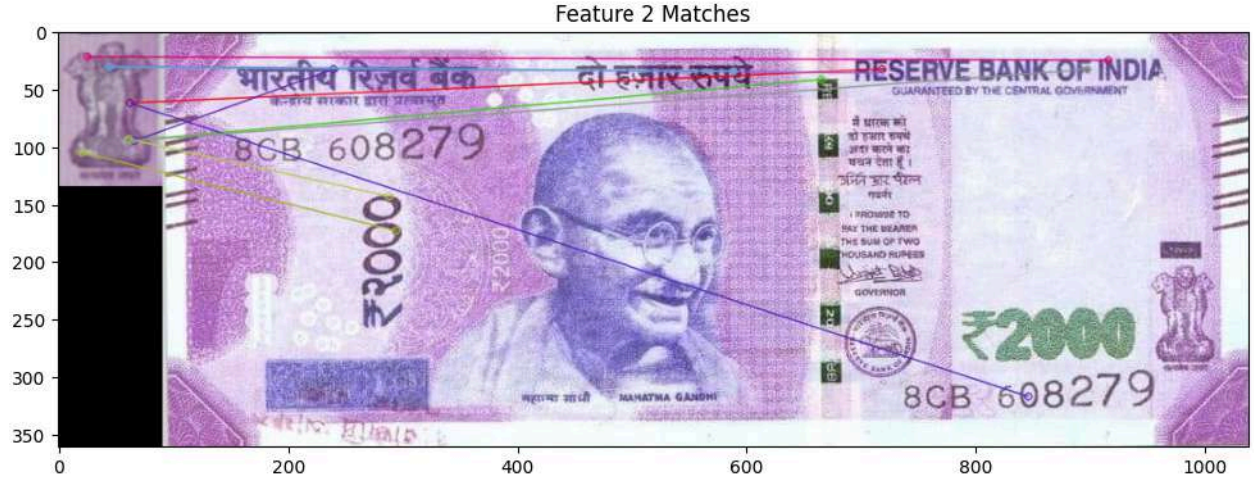
```
Analyzing template 1...
SSIM Score: 0.09931618613903359
ORB Matches Found: 95
```

Feature 1 Matches



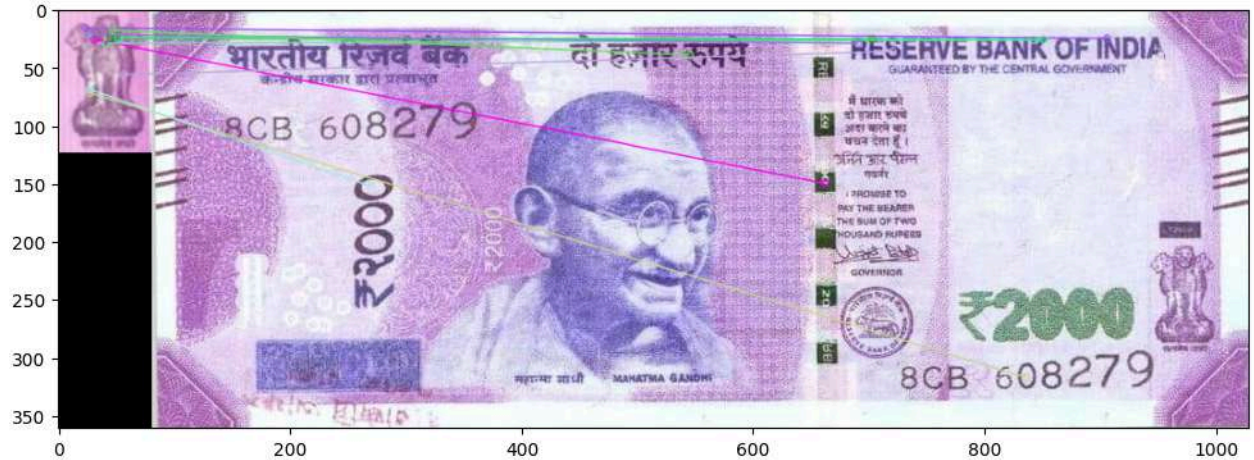

```
Analyzing template 2...
SSIM Score: 0.10139335475008537
ORB Matches Found: 55
```

Feature 2 Matches



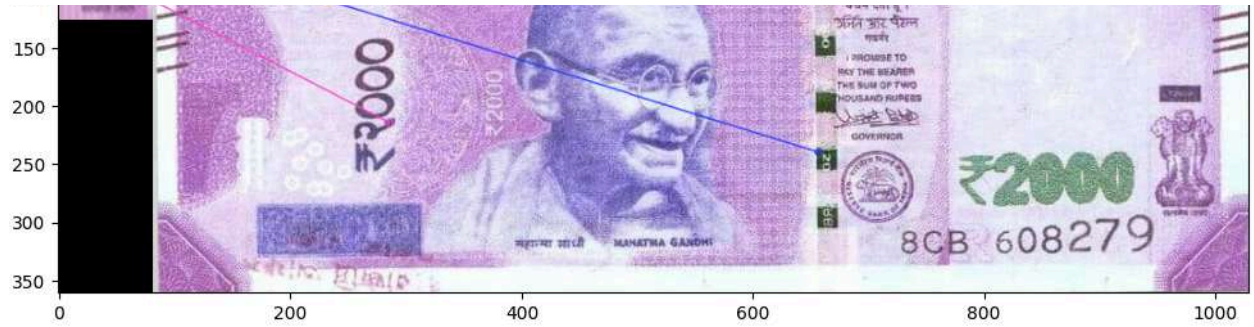

```
Analyzing template 3...
SSIM Score: 0.07141373800404224
ORB Matches Found: 80
```

Feature 3 Matches



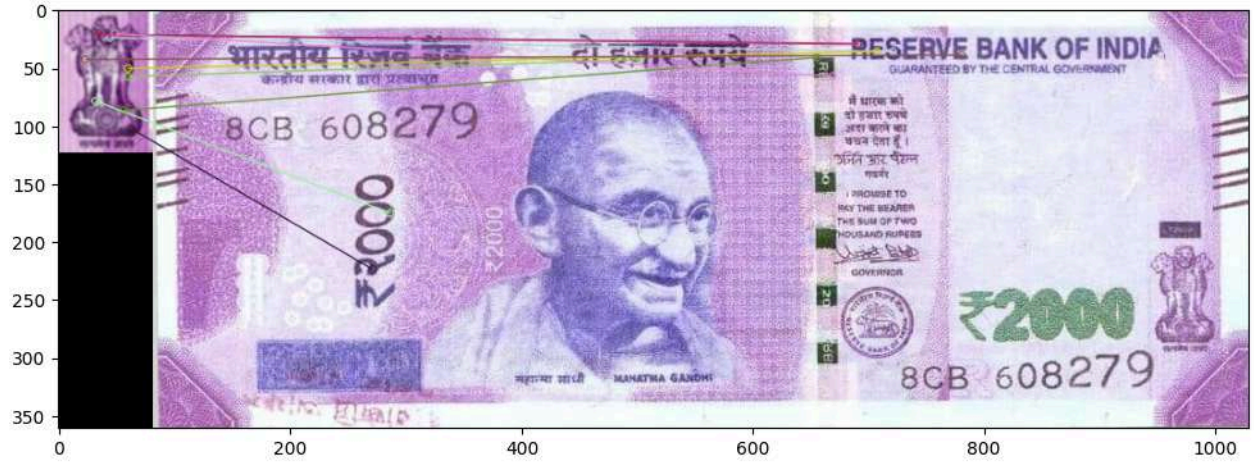

```
Analyzing template 4...
SSIM Score: 0.07414075968960313
ORB Matches Found: 86
```

Feature 4 Matches



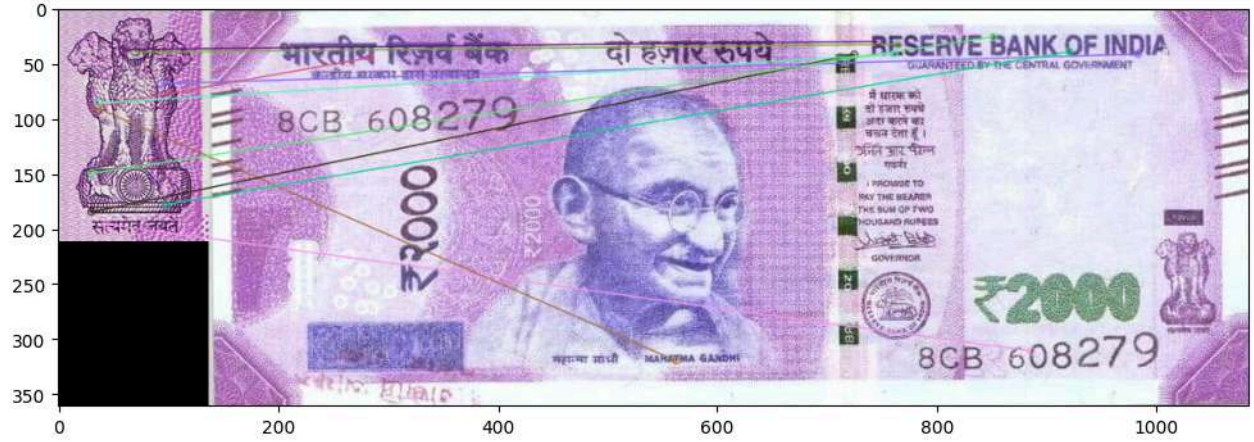

```
Analyzing template 5...
SSIM Score: 0.06840648712209754
ORB Matches Found: 122
```

Feature 5 Matches




```
Analyzing template 6...
SSIM Score: 0.04380984120118405
ORB Matches Found: 185
```

Feature 6 Matches



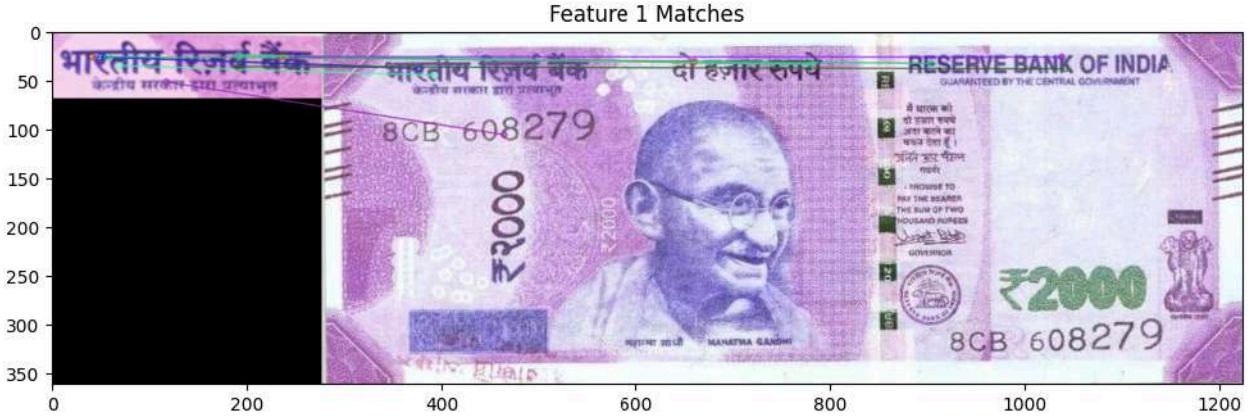

```
Best Match: Feature 2 with SSIM 0.10139335475008537
ORB detected the feature successfully.
```

FEATURE 3 - भारतीय रिजर्व बैंक Symbol

```
# Input paths
currency_img_path = "/content/2000_s9.jpg"  # Update with the actual currency note file
emblem_folder_path = "/content/MyDrive/MyDrive/Dataset/2000_Features Dataset/Feature 3"

# Call the process_images function
process_images(currency_img_path, emblem_folder_path)
```

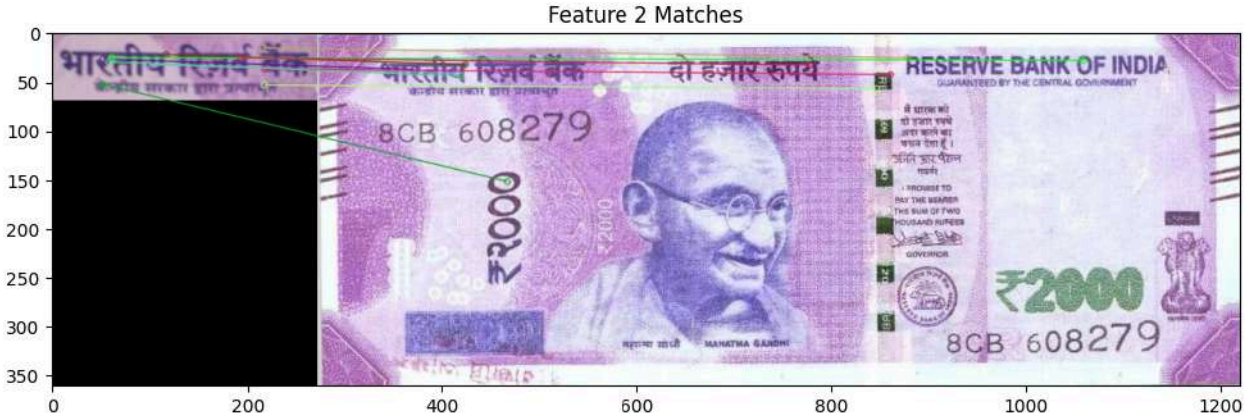
```
Analyzing template 1...
SSIM Score: 0.07046163149561602
ORB Matches Found: 148
```

Feature 1 Matches



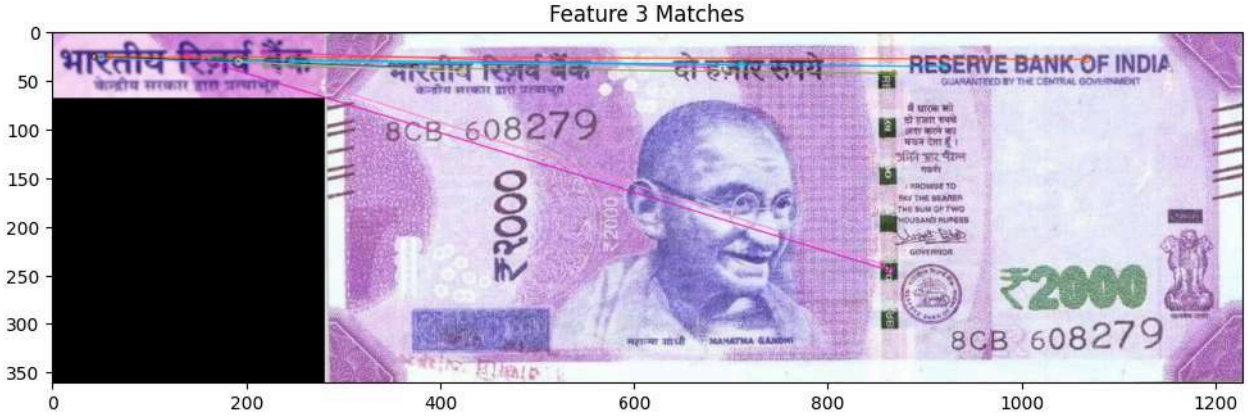

```
Analyzing template 2...
SSIM Score: 0.09345900308115647
ORB Matches Found: 138
```

Feature 2 Matches



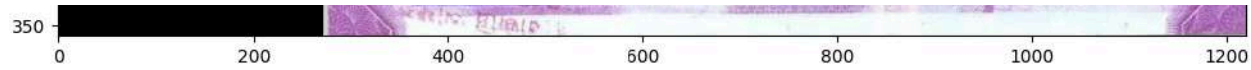

```
Analyzing template 3...
SSIM Score: 0.06727285924004199
ORB Matches Found: 161
```

Feature 3 Matches



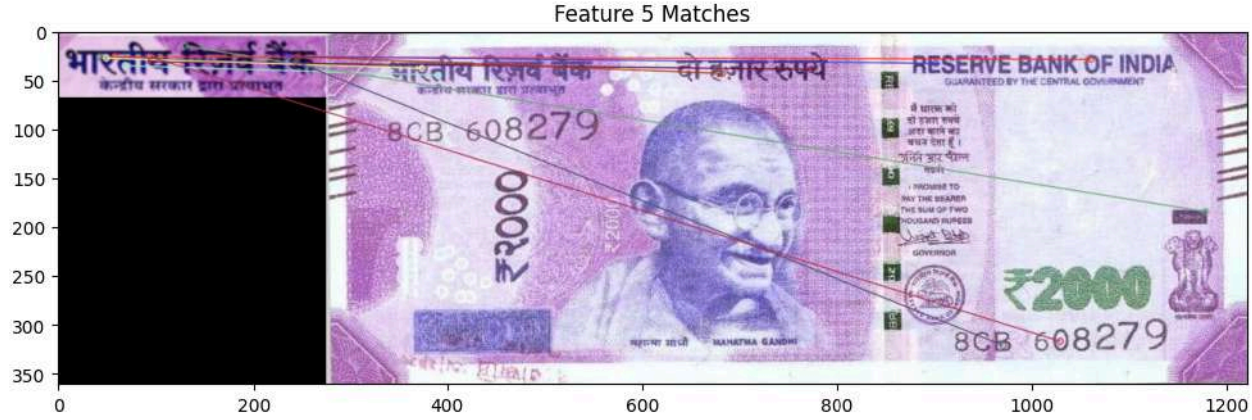

```
Analyzing template 4...
SSIM Score: 0.08240457552972029
ORB Matches Found: 142
```

Feature 4 Matches



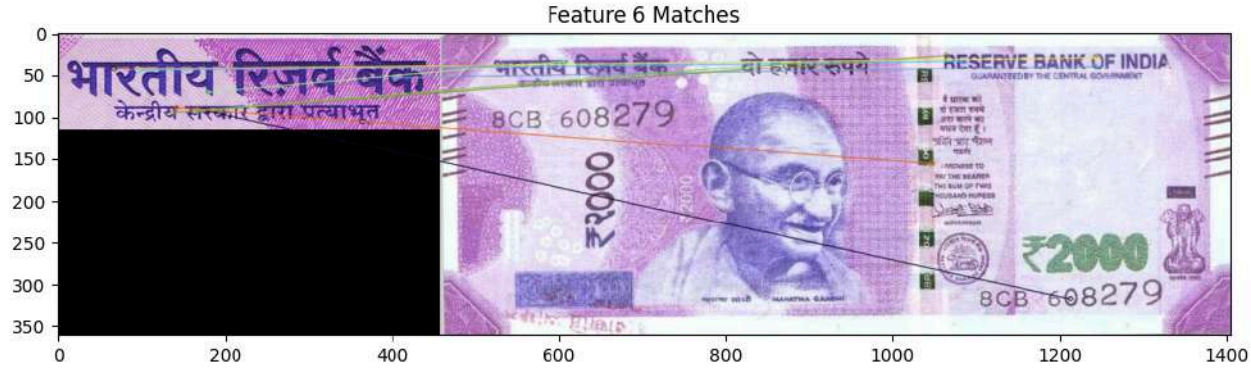
```
Analyzing template 5...
SSIM Score: 0.07669876172513597
ORB Matches Found: 162
```

Feature 5 Matches




```
Analyzing template 6...
SSIM Score: 0.06361980193220979
ORB Matches Found: 208
```

Feature 6 Matches




```
Best Match: Feature 2 with SSIM 0.09345900308115647
ORB detected the feature successfully.
```

Feature 4 - RESERVE BANK OF INDIA Symbol

```
# Input paths
currency_img_path = "/content/2000_s9.jpg"  # Update with the actual currency note file
emblem_folder_path = "/content/MyDrive/MyDrive/Dataset/2000_Features Dataset/Feature 4"

# Call the process_images function
process_images(currency_img_path, emblem_folder_path)
```

```
Analyzing template 1...
SSIM Score: 0.033277346213558094
ORB Matches Found: 163
```

Feature 1 Matches


```
Analyzing template 2...
SSIM Score: 0.059481409833345954
ORB Matches Found: 193
```

Feature 2 Matches


```
Analyzing template 3...
SSIM Score: 0.04922240834317036
ORB Matches Found: 172
```

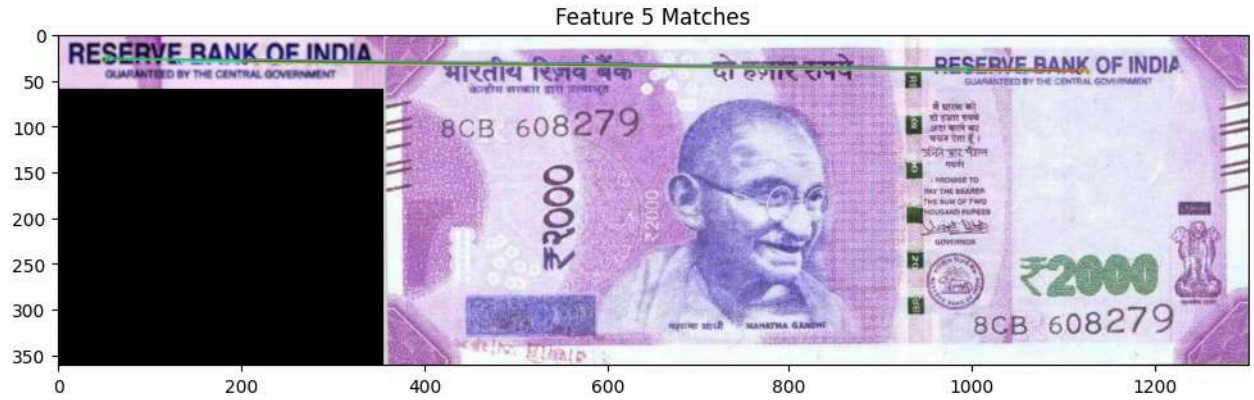
Feature 3 Matches


```
Analyzing template 4...
SSIM Score: 0.028066480621232858
ORB Matches Found: 160
```

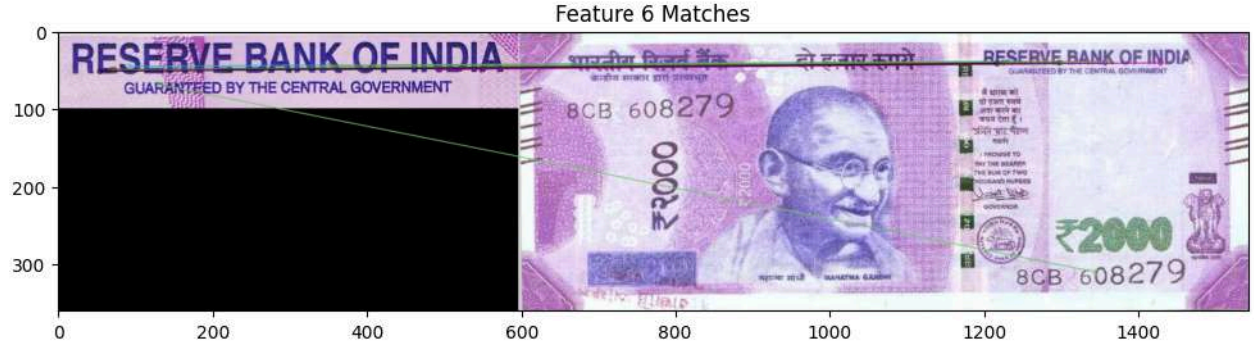
Feature 4 Matches


```
Analyzing template 5...
```

```
Analyzing template 5...
SSIM Score: 0.02722353284759234
ORB Matches Found: 156
```




```
Analyzing template 6...
SSIM Score: 0.08459171870988748
ORB Matches Found: 199
```




```
Best Match: Feature 6 with SSIM 0.08459171870988748
ORB detected the feature successfully.
```

This can be repeated for all the features in the Currency Note

Complete Code

Fake Note

```
import cv2
import numpy as np
from skimage.metrics import structural_similarity as ssim
import os
import pandas as pd

# Inputs
currency_img_path = "/content/2000_f5.jpg"  # Path to the currency note
features_folder_paths = [  # Paths to all feature folders
    f"/content/MyDrive/MyDrive/Dataset/2000_Features Dataset/Feature {i}"
    for i in range(1, 8)
]

# Thresholds
SSIM_THRESHOLD = 0.1
ORB_MATCH_THRESHOLD = 120
```

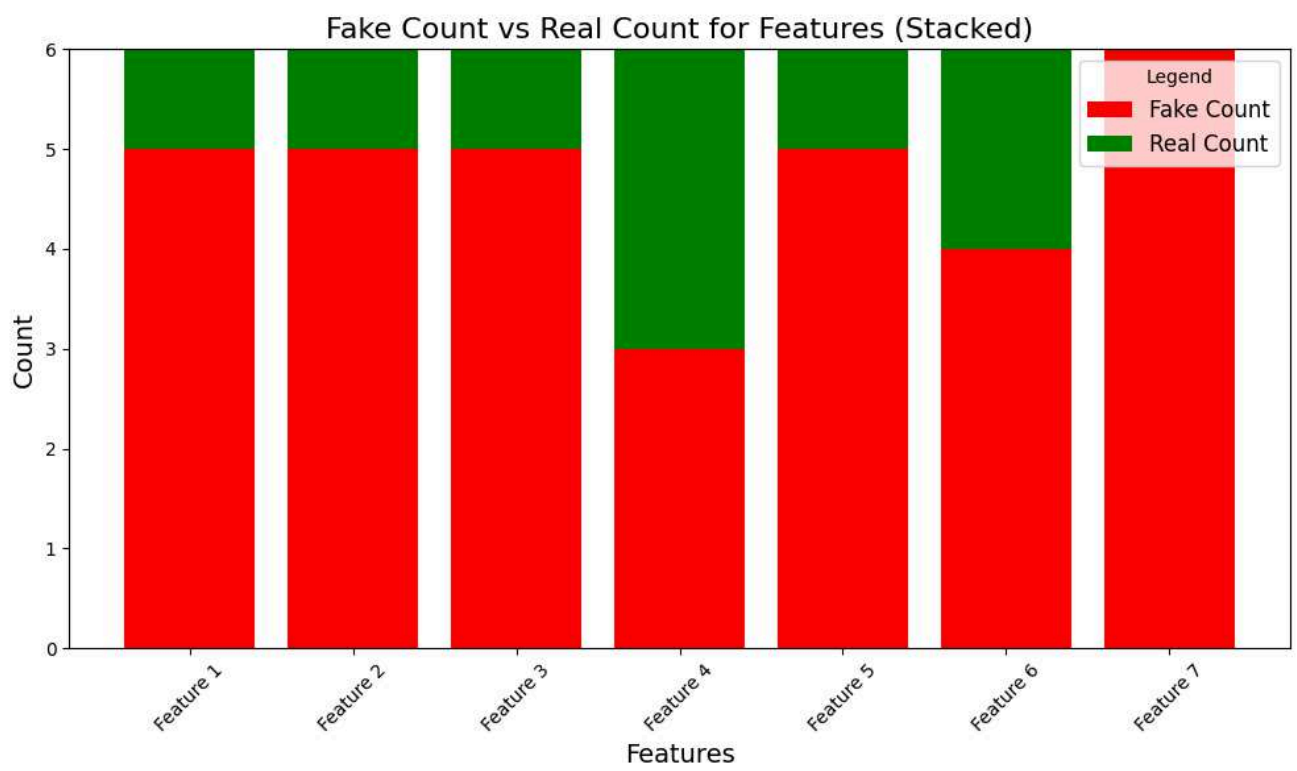
```
    # Define evaluation matrix
    evaluation_matrix = []

    # SSIM Calculation Function
    def calculateSSIM(template_img, query_img):
        min_w = min(template_img.shape[1], query_img.shape[1])
        min_h = min(template_img.shape[0], query_img.shape[0])

        # Resize images to the minimum width and height
        img1 = cv2.resize(template_img, (min_w, min_h))
        img2 = cv2.resize(query_img, (min_w, min_h))

        # Convert to grayscale
        img1 = cv2.cvtColor(img1, cv2.COLOR_BGR2GRAY)
        img2 = cv2.cvtColor(img2, cv2.COLOR_BGR2GRAY)

        # Compute SSIM score
        score = ssim(img1, img2)
        return score

    # ORB Calculation Function
    def computeORB(template_img, query_img):
        orb = cv2.ORB_create(
            nfeatures=700,
            scaleFactor=1.2,
            nlevels=8,
            edgeThreshold=15
        )

        kpts1, descs1 = orb.detectAndCompute(template_img, None)
        kpts2, descs2 = orb.detectAndCompute(query_img, None)

        bf = cv2.BFMatcher(cv2.NORM_HAMMING, crossCheck=True)
        matches = bf.match(descs1, descs2)
        dmatches = sorted(matches, key=lambda x: x.distance)

        return len(dmatches)  # Return number of matches found

    # Process Images for Each Feature
    def process_feature(currency_img_path, emblem_folder_path, feature_name):
        # Load the currency image
        currency_img = cv2.imread(currency_img_path)

        # Load emblem images from the feature folder
        emblem_images = [
            cv2.imread(os.path.join(emblem_folder_path, img))
            for img in os.listdir(emblem_folder_path) if img.endswith('.jpg')
        ]

        ssim_scores = []
        orb_matches = []

        print(f"\nAnalyzing {feature_name} ...")  # Dynamic feature name

        for template_count, emblem in enumerate(emblem_images, start=1):
```

```
            print(f"--> Template {template_count}:")

            # SSIM Analysis
            ssim_score = calculateSSIM(emblem, currency_img)
            print(f"    SSIM Score: {ssim_score}")
            ssim_scores.append(ssim_score)

            # ORB Analysis
            orb_match_count = computeORB(emblem, currency_img)
            print(f"    ORB Matches Found: {orb_match_count}")
            orb_matches.append(orb_match_count)

        # Calculate thresholds
        # median_ssim =0.1
        median_ssim = np.median(ssim_scores)
        median_orb = np.median(orb_matches)
        # median_orb = 120

        # Determine the majority classification for this feature
        fake_count = sum(
            1 for score, orb in zip(ssim_scores, orb_matches)
            if score < median_ssim or orb < median_orb
        )
        real_count = len(ssim_scores) - fake_count

        feature_result = "FAKE" if fake_count > real_count else "REAL"

        # Add result to evaluation matrix
        evaluation_matrix.append({
            "Feature": feature_name,
            "Median SSIM Score": median_ssim,
            "Median ORB Matches": median_orb,
            "Fake Count": fake_count,
            "Real Count": real_count,
            "Result": feature_result
        })

    # Main Processing Loop for All Features
    for i, feature_folder in enumerate(features_folder_paths, start=1):
        process_feature(currency_img_path, feature_folder, f"Feature {i}")

    # Final Classification
    total_fake_features = sum(1 for feature in evaluation_matrix if feature["Result"] == "FAK
    total_real_features = len(evaluation_matrix) - total_fake_features
    final_result = "FAKE" if total_fake_features > total_real_features else "REAL"

    # Display the evaluation matrix
    evaluation_df = pd.DataFrame(evaluation_matrix)
    print("\nEvaluation Matrix:")
    print(evaluation_df[['Feature','Fake Count','Real Count','Result']])

    # Print final classification result
    # print(f"\nFinal Classification: The currency is {final_result}.")

    # Calculate probabilities
```

```
total_features = len(evaluation_matrix)
probability_real = (total_real_features / total_features) * 100
probability_fake = (total_fake_features / total_features) * 100

# Display probabilities
print(f"\nProbability of being REAL: {probability_real:.2f}%")
print(f"Probability of being FAKE: {probability_fake:.2f}%")

# Save the evaluation matrix to a CSV file
# evaluation_df.to_csv('/content/evaluation_results_all_features.csv', index=False)
```

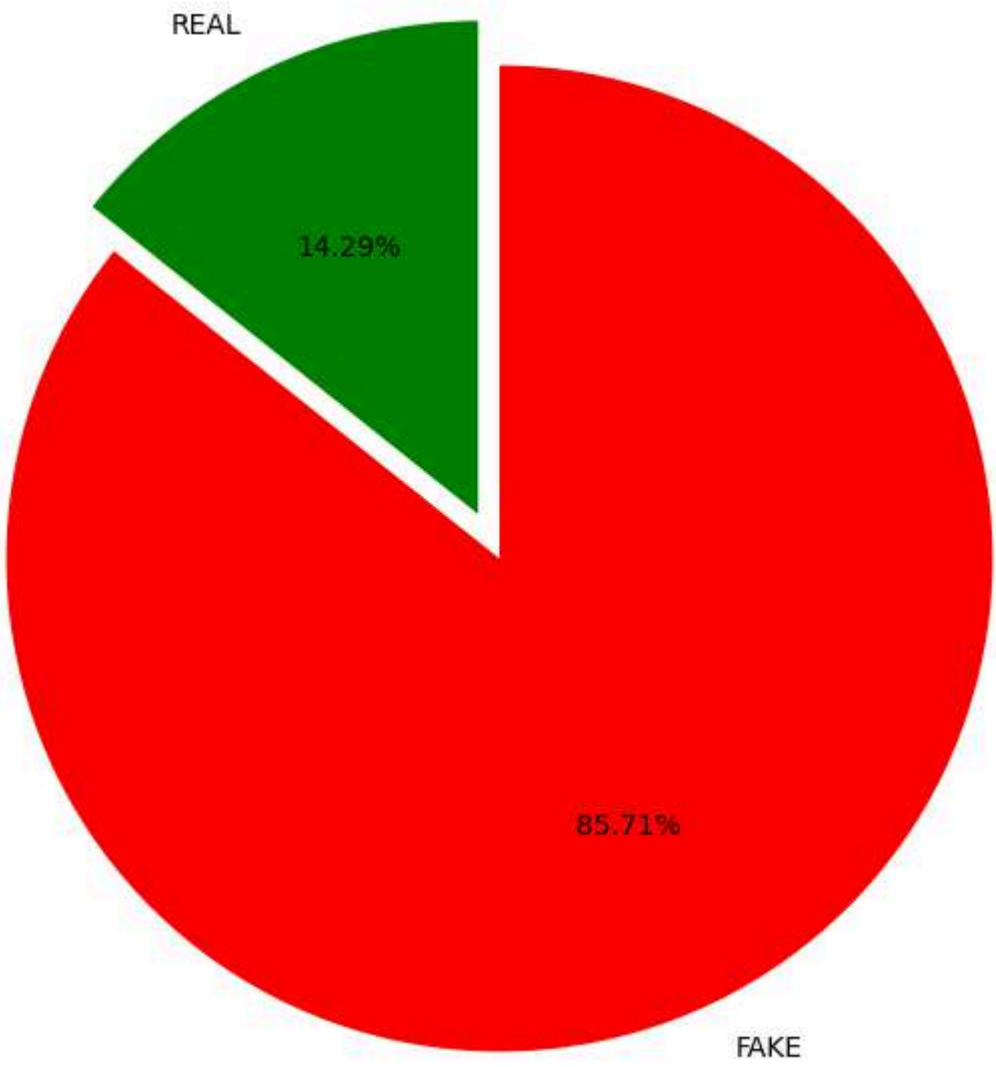
```
      Feature  Fake Count  Real Count Result
0  Feature 1           5           1   FAKE
1  Feature 2           5           1   FAKE
2  Feature 3           5           1   FAKE
3  Feature 4           3           3   REAL
4  Feature 5           5           1   FAKE
5  Feature 6           4           2   FAKE
6  Feature 7           6           0   FAKE

Probability of being REAL: 14.29%
Probability of being FAKE: 85.71%
```

```
# Prepare the data for stacking
evaluation_df['Total Count'] = evaluation_df['Fake Count'] + evaluation_df['Real Count']

# Plot
plt.figure(figsize=(10, 6))
plt.bar(evaluation_df['Feature'], evaluation_df['Fake Count'], color='red', label='Fake C
plt.bar(evaluation_df['Feature'], evaluation_df['Real Count'], bottom=evaluation_df['Fake

# Adding labels and legend
plt.title("Fake Count vs Real Count for Features (Stacked)", fontsize=16)
plt.xlabel("Features", fontsize=14)
plt.ylabel("Count", fontsize=14)
plt.legend(title="Legend", fontsize=12)
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```




```
# Pie chart for Probabilities
probabilities = [probability_real, probability_fake]
labels = ['REAL', 'FAKE']
colors = ['green', 'red']
```

```
plt.figure(figsize=(8, 8))
plt.pie(
    probabilities,
    labels=labels,
    autopct='%1.2f%%',
    startangle=90,
    colors=colors,
    explode=(0.1, 0)  # Highlight "REAL" section
)
plt.title("Probability Distribution: REAL vs FAKE", fontsize=16)
plt.show()
```



Start coding or generate with AI.

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Real Note

```
import cv2
import numpy as np
from skimage.metrics import structural_similarity as ssim
import os
import pandas as pd

# Inputs
currency_img_path = "/content/2000_s1.jpg"  # Path to the currency note
features_folder_paths = [  # Paths to all feature folders
    f"/content/MyDrive/MyDrive/Dataset/2000_Features Dataset/Feature {i}"
    for i in range(1, 8)
]

# Thresholds
SSIM_THRESHOLD = 0.85
# SSIM_THRESHOLD = 0.85
# ORB_MATCH_THRESHOLD = 100
ORB_MATCH_THRESHOLD = 100

# Define evaluation matrix
evaluation_matrix = []

# SSIM Calculation Function
def calculateSSIM(template_img, query_img):
    min_w = min(template_img.shape[1], query_img.shape[1])
    min_h = min(template_img.shape[0], query_img.shape[0])

    # Resize images to the minimum width and height
    img1 = cv2.resize(template_img, (min_w, min_h))
    img2 = cv2.resize(query_img, (min_w, min_h))
```