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Image and Video Analytics Assignment 2

Lab Task 1: Setup and Basic Extraction

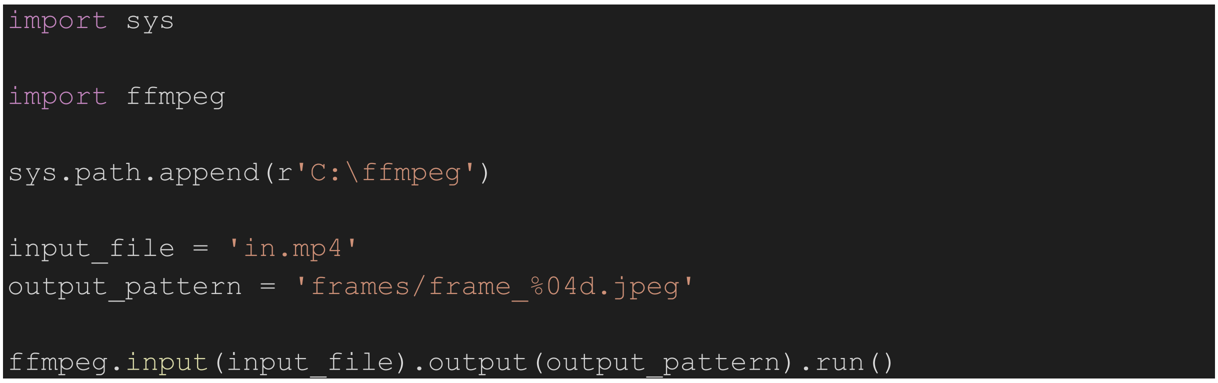
Objective:

Install the necessary tools and libraries, and extract frame information from a video.

Steps:

1. **Install ffmpeg and ffmpeg-python**:
   - Install the ffmpeg tool and the ffmpeg-python library.
2. **Extract Frame Information**:
   - Extract frame information from a sample video.

Code:



```
import sys

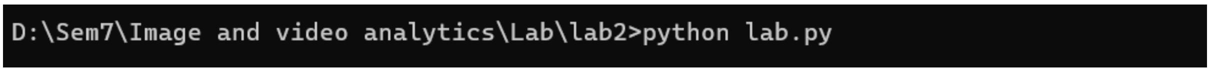
import ffmpeg

sys.path.append(r'C:\ffmpeg')

input_file = 'in.mp4'
output_pattern = 'frames/frame_%04d.jpeg'

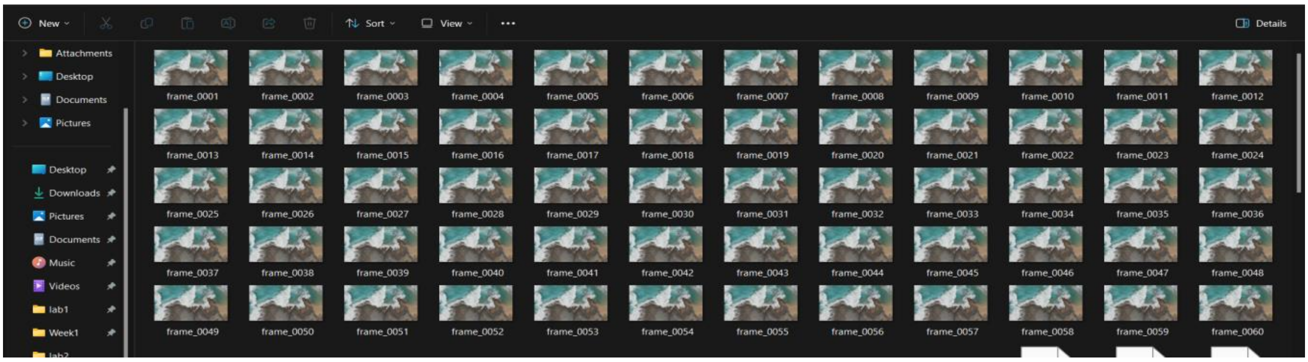
ffmpeg.input(input_file).output(output_pattern).run()
```

my spyder console is not recognizing **'ffmpeg'** I'm running it in **'command prompt'**

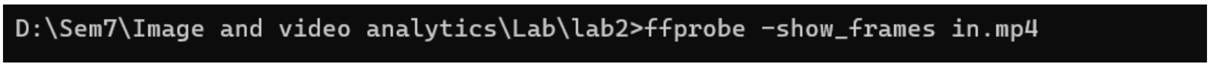


```
D:\Sem7\Image and video analytics\Lab\lab2>python lab.py
```

So after running this we get our frames

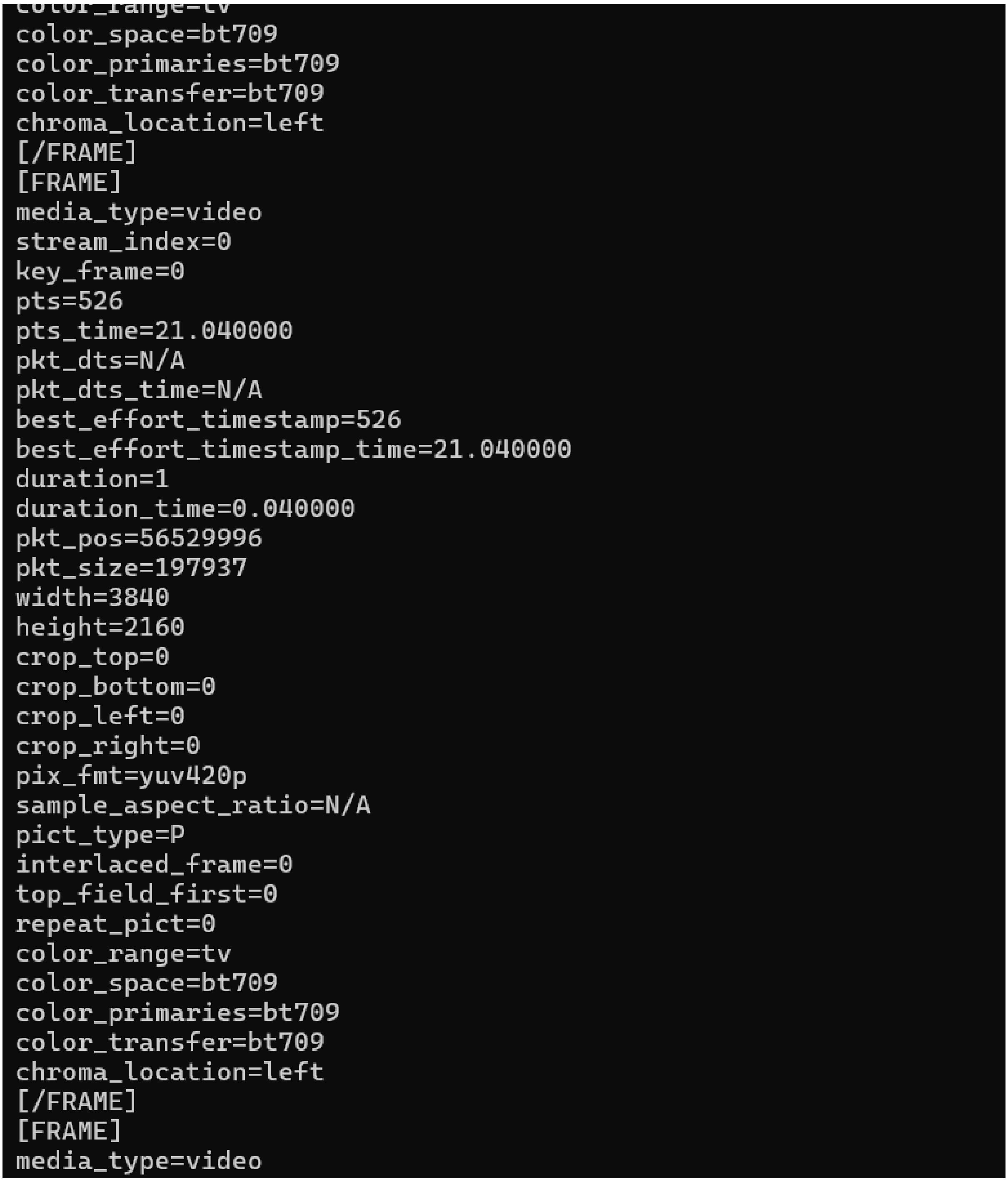


To get information about each frame we can run this prompt in cmd



```
D:\Sem7\Image and video analytics\Lab\lab2>ffprobe -show_frames in.mp4
```

This will display information about each frame



```
color_range=tv
color_space=bt709
color_primaries=bt709
color_transfer=bt709
chroma_location=left
[/FRAME]
[FRAME]
media_type=video
stream_index=0
key_frame=0
pts=526
pts_time=21.040000
pkt_dts=N/A
pkt_dts_time=N/A
best_effort_timestamp=526
best_effort_timestamp_time=21.040000
duration=1
duration_time=0.040000
pkt_pos=56529996
pkt_size=197937
width=3840
height=2160
crop_top=0
crop_bottom=0
crop_left=0
crop_right=0
pix_fmt=yuv420p
sample_aspect_ratio=N/A
pict_type=P
interlaced_frame=0
top_field_first=0
repeat_pict=0
color_range=tv
color_space=bt709
color_primaries=bt709
color_transfer=bt709
chroma_location=left
[/FRAME]
[FRAME]
media_type=video
```

Lab Task 2: Frame Type Analysis

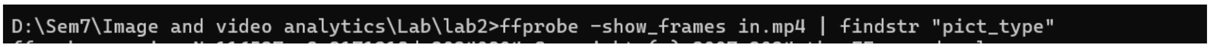
Objective:

Analyze the extracted frame information to understand the distribution of I, P, and B frames in a video.

Steps:

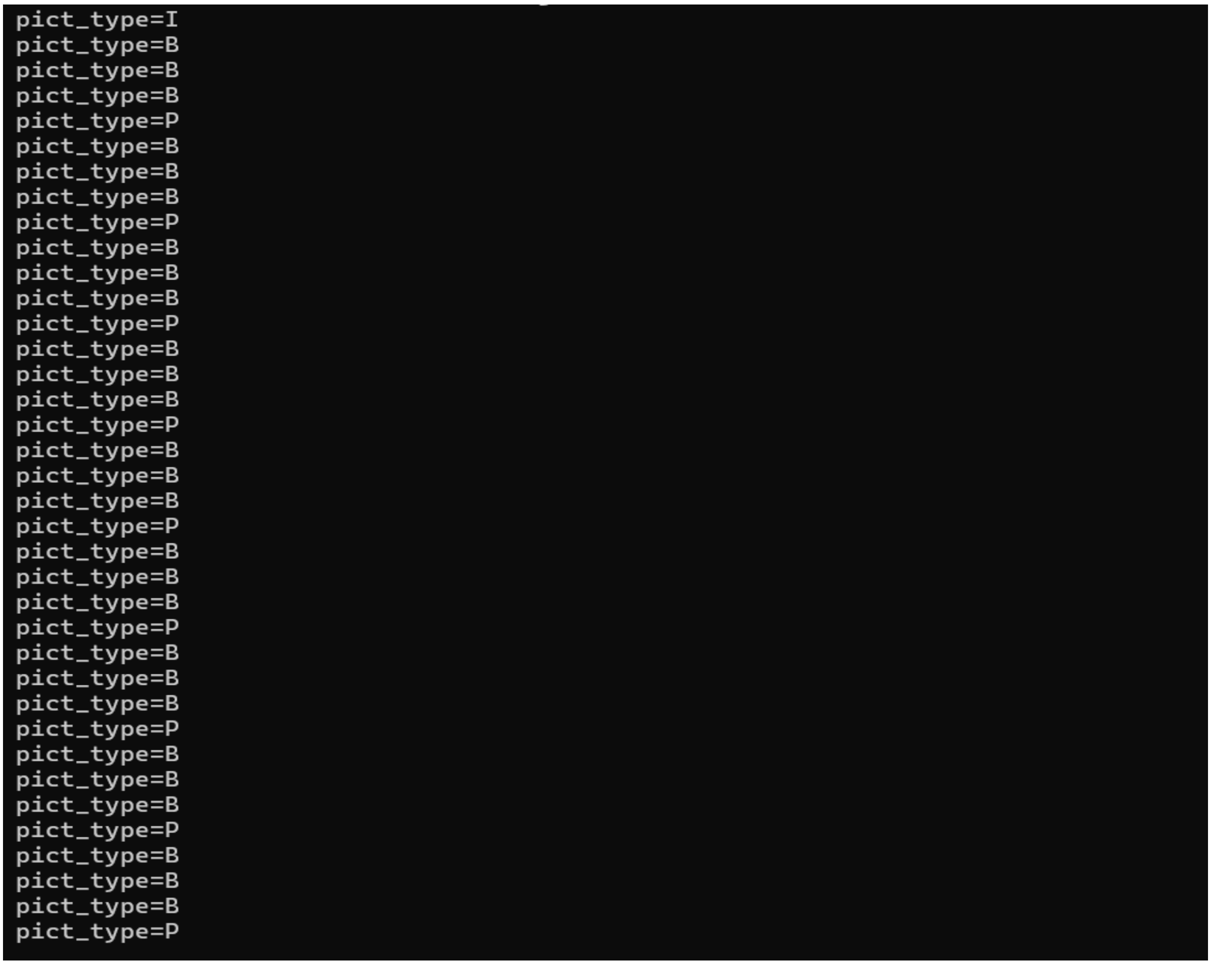
1. **Modify the Script**:
   - Count the number of I, P, and B frames.
   - Calculate the percentage of each frame type in the video.
2. **Analyze Frame Distribution**:
   - Plot the distribution of frame types using a library like matplotlib.
   - Plot a pie chart or bar graph showing the distribution of frame types using matplotlib.

To get type of frame information, Enter



```
D:\Sem7\Image and video analytics\Lab\lab2>ffprobe -show_frames in.mp4 | findstr "pict_type"
```

This will display type of each frame



```
pict_type=I
pict_type=B
pict_type=B
pict_type=B
pict_type=P
pict_type=B
pict_type=B
pict_type=B
pict_type=P
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pict_type=P
```

We can extract this and information to analyse and visualize the frames to get information

Code:

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frame_types =["I"
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# Count the number of each frame type
frame_counts = {'I': 0, 'P': 0, 'B': 0}
for frame_type in frame_types:
    if frame_type in frame_counts:
        frame_counts[frame_type] += 1

# Calculate total frames
total_frames = len(frame_types)

# Calculate percentage of each frame type
frame_percentages = {ftype: (count / total_frames) * 100 for ftype,
count in frame_counts.items()}

# Print the results
print(f"Frame Counts: {frame_counts}")
print(f"Frame Percentages: {frame_percentages}")


import matplotlib.pyplot as plt

def plot_distribution(frame_counts, frame_percentages):
    # Plotting the Pie Chart
    plt.figure(figsize=(12, 6))
    plt.subplot(1, 2, 1)
    plt.pie(frame_counts.values(), labels=frame_counts.keys(),
autopct='%1.1f%%')
    plt.title('Frame Type Distribution (Pie Chart)')

    # Plotting the Bar Graph
    plt.subplot(1, 2, 2)
    plt.bar(frame_counts.keys(), frame_counts.values(), color=['red',
'green', 'blue'])
    plt.xlabel('Frame Type')
    plt.ylabel('Count')
    plt.title('Frame Type Distribution (Bar Graph)')

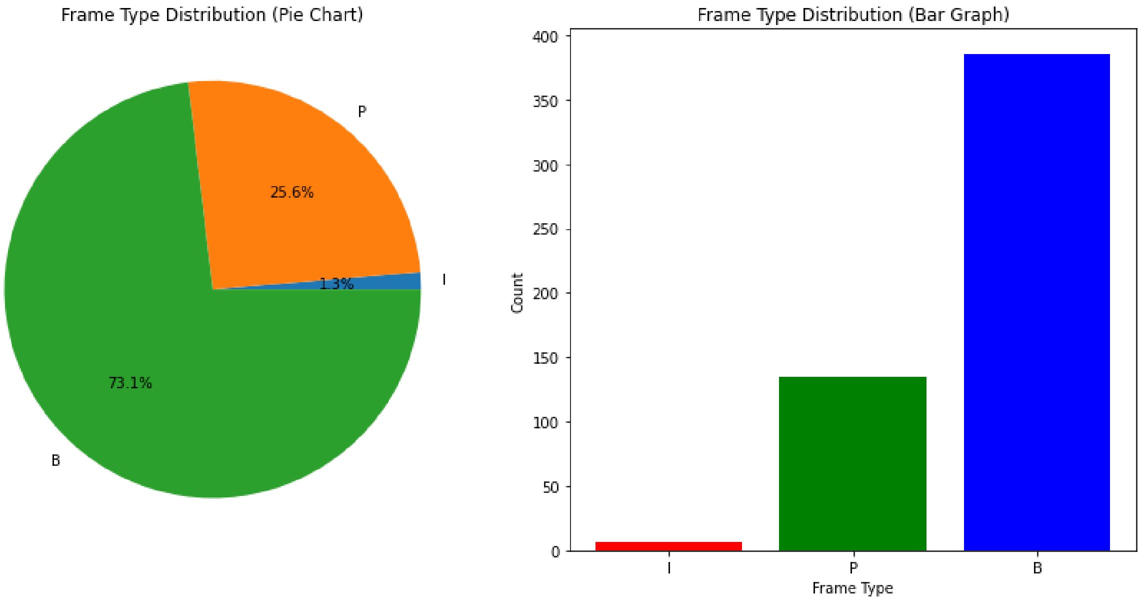
    plt.tight_layout()
    plt.show()
```

```
plot_distribution(frame_counts, frame_percentages)
```

Output:

Frame Counts: {'I': 7, 'P': 135, 'B': 386}

Frame Percentages: {'I': 1.3257575757575757, 'P': 25.568181818181817, 'B': 73.10606060606061}



Lab Task 3: Visualizing Frames

Objective:

Extract actual frames from the video and display them using Python.

Steps:

1. **Extract Frames**:
   - Use ffmpeg to extract individual I, P, and B frames from the video.
   - Save these frames as image files.
2. **Display Frames**:
   - Use a library like PIL (Pillow) or opencv-python to display the extracted frames.

Tasks:

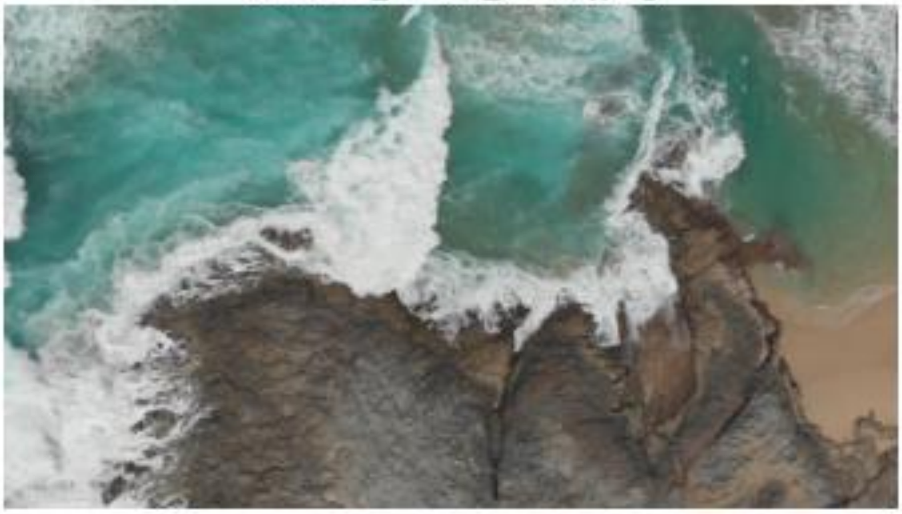
1. Save I, P, and B frames as separate image files using ffmpeg.
2. Use PIL or opencv-python to load and display these frames in a Python script.
3. Compare the visual quality of I, P, and B frames.

Code:

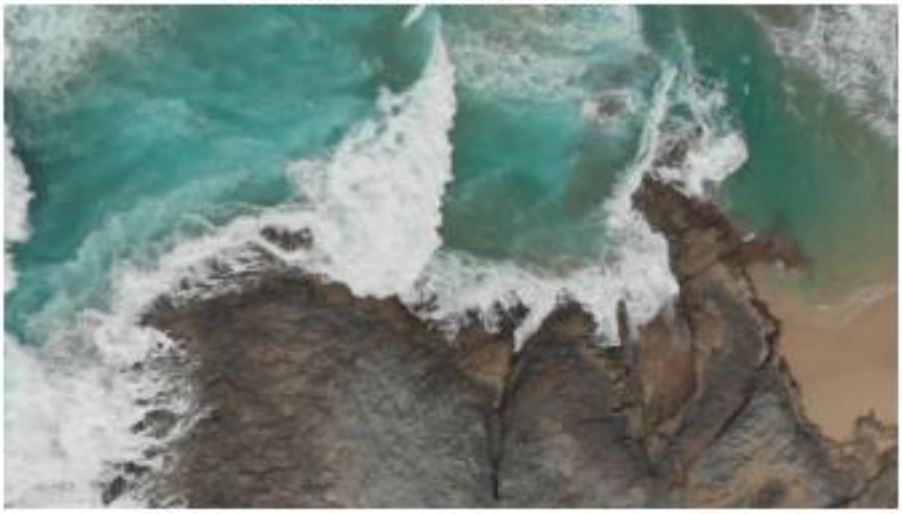
```python
import os
# Path to frames directory
frames_dir = './frames/'  # Adjust this path as needed

# Rename frames
for i, frame_type in enumerate(frame_types):
    original_filename = f"frame_{i+1:04d}.jpeg"
    new_filename = f"{frame_type}_frame_{i+1:04d}.jpeg"
    original_path = os.path.join(frames_dir, original_filename)
    new_path = os.path.join(frames_dir, new_filename)
    if os.path.exists(original_path):
        os.rename(original_path, new_path)
    else:
        print(f"File {original_filename} does not exist in the directory.")

import cv2
import matplotlib.pyplot as plt

# Define a function to display images using OpenCV
def display_frames(frame_paths):
    for path in frame_paths:
        # Load the image
        image = cv2.imread(path)
        # Convert BGR to RGB for displaying using matplotlib
        image_rgb = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
        plt.imshow(image_rgb)
        plt.title(f"Frame: {os.path.basename(path)}")
        plt.axis('off')
        plt.show()

# Example paths (Replace with actual paths after renaming)
example_I_frame = os.path.join(frames_dir, 'I_frame_0001.jpeg')
example_P_frame = os.path.join(frames_dir, 'P_frame_0005.jpeg')
example_B_frame = os.path.join(frames_dir, 'B_frame_0002.jpeg')

# Displaying example frames
display_frames([example_I_frame, example_P_frame, example_B_frame])
```

Quality comparison of different image types:

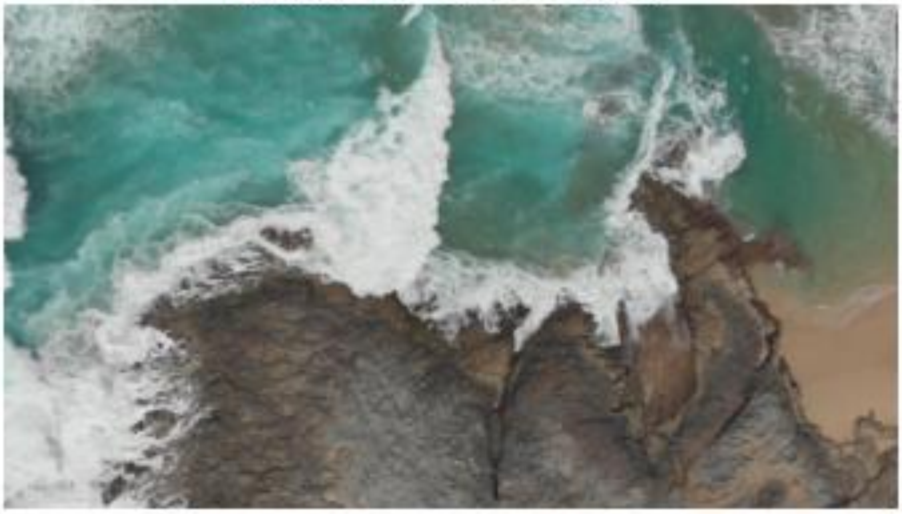
Frame: I_frame_0001.jpeg



Frame: P_frame_0005.jpeg



Frame: B_frame_0002.jpeg



Lab Task 4: Frame Compression Analysis

Objective:

Analyze the compression efficiency of I, P, and B frames.

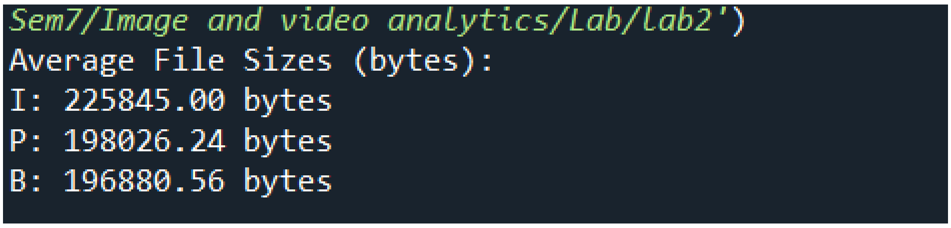
Steps:

1. **Calculate Frame Sizes**:
   - Calculate the file sizes of extracted I, P, and B frames.
   - Compare the average file sizes of each frame type.
2. **Compression Efficiency**:
   - Discuss the role of each frame type in video compression.
   - Analyze why P and B frames are generally smaller than I frames.

Code:

```
import os

# Directory containing the renamed frames
frames_dir = './frames/'

# Initialize dictionaries to store sizes and counts
frame_sizes = {'I': [], 'P': [], 'B': []}

# Calculate the file sizes
for filename in os.listdir(frames_dir):
    if filename.startswith('I_') or filename.startswith('P_') or
filename.startswith('B_'):
        frame_type = filename.split('_')[0]
        file_path = os.path.join(frames_dir, filename)
        file_size = os.path.getsize(file_path)
        frame_sizes[frame_type].append(file_size)

# Calculate average sizes
average_sizes = {frame_type: sum(sizes) / len(sizes) if sizes else 0
for frame_type, sizes in frame_sizes.items()}

# Print out the results
print("Average File Sizes (bytes):")
for frame_type, avg_size in average_sizes.items():
    print(f"{frame_type}: {avg_size:.2f} bytes")
```

Output:



```
Sem7/Image and video analytics/Lab/lab2')
Average File Sizes (bytes):
I: 225845.00 bytes
P: 198026.24 bytes
B: 196880.56 bytes
```

Analysis

These results align more closely with typical expectations, where I-frames are larger than P-frames and B-frames:

1. **I-Frames** are expected to be larger because they store a complete image without reference to other frames.
2. **P-Frames** are smaller than I-frames as they only store differences from previous frames, using predictive coding.
3. **B-Frames** are usually the smallest, leveraging both past and future frames to encode differences with high efficiency.

Lab Task 5: Advanced Frame Extraction

Objective:

Extract frames from a video and reconstruct a part of the video using only I frames.

Steps:

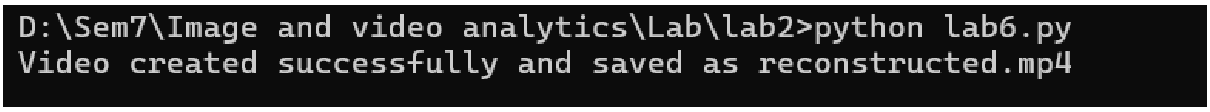
1. **Extract and Save I Frames**:
   - Extract I frames from the video and save them as separate image files.
2. **Reconstruct Video**:
   - Use the extracted I frames to reconstruct a portion of the video.
   - Create a new video using these I frames with a reduced frame rate.

Code:

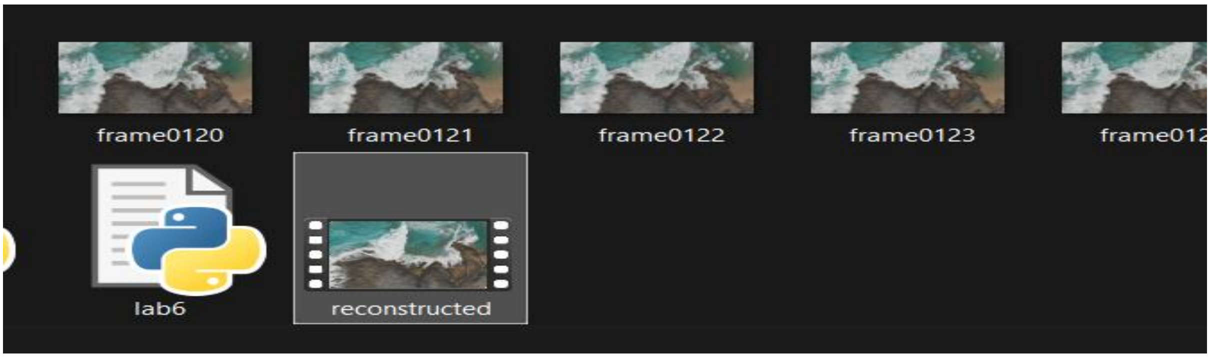
```
import cv2
import os

# Path to the directory containing I frames
i_frame_dir = './I_frames/'  # Update this path as needed
output_video_path = 'reconstructed.mp4'  # Output path for the
reconstructed video

# Define frame rate (we'll use 3.5 fps for at least 2 seconds duration)
frame_rate = 3.5
num_frames = 7
```

```
# Get the list of frame file names
frame_files = [f for f in sorted(os.listdir(i_frame_dir)) if
f.startswith('I_frame_')]

# Check if the number of frames matches the expected count
if len(frame_files) != num_frames:
    print(f"Error: Expected {num_frames} frames, found
{len(frame_files)}.")
else:
    # Load the first frame to get the frame size
    first_frame = cv2.imread(os.path.join(i_frame_dir, frame_files[0]))
    height, width, layers = first_frame.shape

    # Define the codec and create VideoWriter object
    fourcc = cv2.VideoWriter_fourcc(*'mp4v')  # Codec for .mp4 files
    video_writer = cv2.VideoWriter(output_video_path, fourcc,
frame_rate, (width, height))

    # Write each frame to the video
    for frame_file in frame_files:
        frame_path = os.path.join(i_frame_dir, frame_file)
        frame = cv2.imread(frame_path)
        video_writer.write(frame)

    # Release the video writer
    video_writer.release()
    print(f"Video created successfully and saved as
{output_video_path}")
```

Output:



```
D:\Sem7\Image and video analytics\Lab\lab2>python lab6.py
Video created successfully and saved as reconstructed.mp4
```


frame0120
frame0121
frame0122
frame0123
frame012
lab6
reconstructed