Name: Nguyễn Trương Xuân Nghiêm

Student ID: 2151010246

Exercise 1: Object Tracking

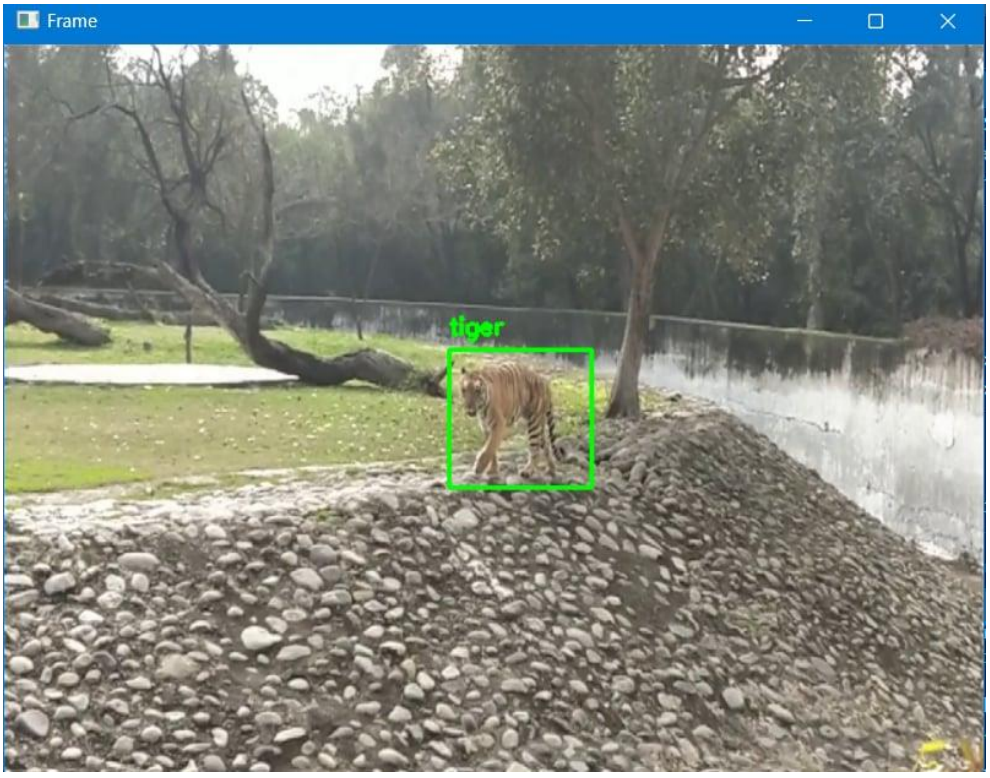
Source Code:

```python
import cv2
import numpy as np

# Initialize variables
drawing = False
ix, iy = -1, -1
bbox = []

# Mouse callback function to draw a rectangle


def draw_rectangle(event, x, y, flags, param):
    global ix, iy, drawing, bbox

    if event == cv2.EVENT_LBUTTONDOWN:
        drawing = True
        ix, iy = x, y

    elif event == cv2.EVENT_MOUSEMOVE:
        if drawing:
            img_copy = frame.copy()
            cv2.rectangle(img_copy, (ix, iy), (x, y), (0, 255, 0), 2)
            cv2.putText(img_copy, 'tiger', (ix, iy - 10),
                        cv2.FONT_HERSHEY_SIMPLEX, 0.5, (0, 255, 0), 2)
            cv2.imshow('Frame', img_copy)

    elif event == cv2.EVENT_LBUTTONUP:
        drawing = False
        cv2.rectangle(frame, (ix, iy), (x, y), (0, 255, 0), 2)
        bbox.append((ix, iy, x, y))
        cv2.imshow('Frame', frame)


# Initialize video capture
cap = cv2.VideoCapture('tiger.mp4')
```

```python

# Set up the mouse callback
cv2.namedWindow('Frame')
cv2.setMouseCallback('Frame', draw_rectangle)

# Initialize Lucas-Kanade parameters
lk_params = dict(winSize=(15, 15),
                 maxLevel=2,
                 criteria=(cv2.TERM_CRITERIA_EPS | cv2.TERM_CRITERIA_COUNT, 10, 0.03))  # Lucas Kanade

# Read the first frame
ret, frame = cap.read()

# Resize the first frame
frame = cv2.resize(frame, (640, 480))

old_gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)

while cap.isOpened():
    ret, frame = cap.read()
    if not ret:
        break

    # Resize the frame
    frame = cv2.resize(frame, (640, 480))

    # Convert frame to grayscale
    frame_gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)

    # Draw bounding boxes for user-drawn rectangles
    for (startX, startY, endX, endY) in bbox:
        cv2.rectangle(frame, (startX, startY), (endX, endY), (0, 255, 0), 2)
        cv2.putText(frame, 'tiger', (startX, startY - 10),
                    cv2.FONT_HERSHEY_SIMPLEX, 0.5, (0, 255, 0), 2)

```

```
    # Calculate optical flow for the tracked points
    if len(bbox) > 0:
        p0 = np.array([[x + (endX - startX) / 2, y + (endY - startY) / 2]
                       for (x, y, endX, endY) in bbox], dtype=np.float32).reshape(-1, 1, 2)
        p1, st, err = cv2.calcOpticalFlowPyrLK(
            old_gray, frame_gray, p0, None, **lk_params)

        # Update bounding boxes based on optical flow
        for i, (new, old) in enumerate(zip(p1, p0)):
            a, b = new.ravel()
            c, d = old.ravel()
            startX, startY, endX, endY = bbox[i]
            startX += int(a - c)
            startY += int(b - d)
            endX += int(a - c)
            endY += int(b - d)
            bbox[i] = (startX, startY, endX, endY)

            # Draw updated bounding boxes
            cv2.rectangle(frame, (startX, startY),
                          (endX, endY), (0, 255, 0), 2)
            cv2.putText(frame, 'tiger', (startX, startY - 10),
                        cv2.FONT_HERSHEY_SIMPLEX, 0.5, (0, 255, 0), 2)

    # Display the frame
    cv2.imshow('Frame', frame)

    # Update the previous frame and keypress handling
    old_gray = frame_gray.copy()
    key = cv2.waitKey(30) & 0xFF  # adjust the speed of video (1->30)
    if key == ord('q'):
        break

# Release video capture and close all windows
cap.release()
cv2.destroyAllWindows()
```

Result:



Exercise 2: Object Speed Estimation

Source Code:

```python
import cv2
import numpy as np
import time

# Initialize variables
drawing = False
ix, iy = -1, -1
bbox = []
prev_time = None

# Mouse callback function to draw a rectangle


def draw_rectangle(event, x, y, flags, param):
    global ix, iy, drawing, bbox

    if event == cv2.EVENT_LBUTTONDOWN:
        drawing = True
        ix, iy = x, y

    elif event == cv2.EVENT_MOUSEMOVE:
        if drawing:
            img_copy = frame.copy()
            cv2.rectangle(img_copy, (ix, iy), (x, y), (0, 255, 0), 2)
            cv2.putText(img_copy, 'tiger', (ix, iy - 10),
                        cv2.FONT_HERSHEY_SIMPLEX, 0.5, (0, 255, 0), 2)
            cv2.imshow('Frame', img_copy)

    elif event == cv2.EVENT_LBUTTONUP:
        drawing = False
        cv2.rectangle(frame, (ix, iy), (x, y), (0, 255, 0), 2)
        bbox.append((ix, iy, x, y))
        cv2.imshow('Frame', frame)


# Initialize video capture
cap = cv2.VideoCapture('tiger.mp4')
```

```
38
39  # Set up the mouse callback
40  cv2.namedWindow('Frame')
41  cv2.setMouseCallback('Frame', draw_rectangle)
42
43  # Initialize Lucas-Kanade parameters
44  lk_params = dict(winSize=(15, 15),
45                   maxLevel=2,
46                   criteria=(cv2.TERM_CRITERIA_EPS | cv2.TERM_CRITERIA_COUNT, 10, 0.03))
47
48  # Read the first frame
49  ret, frame = cap.read()
50
51  # Resize the first frame
52  frame = cv2.resize(frame, (640, 480))
53
54  old_gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
55
56  while cap.isOpened():
57      ret, frame = cap.read()
58      if not ret:
59          break
60
61      # Resize the frame
62      frame = cv2.resize(frame, (640, 480))
63
64      # Convert frame to grayscale
65      frame_gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
66
67      # Draw bounding boxes for user-drawn rectangles
68      for (startX, startY, endX, endY) in bbox:
69          cv2.rectangle(frame, (startX, startY), (endX, endY), (0, 255, 0), 2)
70          cv2.putText(frame, 'car', (startX, startY - 10),
71                      cv2.FONT_HERSHEY_SIMPLEX, 0.5, (0, 255, 0), 2)
72
```

```
73      # Calculate optical flow for the tracked points
74      if len(bbox) > 0:
75          p0 = np.array([[x + (endX - startX) / 2, y + (endY - startY) / 2]
76                         for (x, y, endX, endY) in bbox], dtype=np.float32).reshape(-1, 1, 2)
77          p1, st, err = cv2.calcOpticalFlowPyrLK(
78              old_gray, frame_gray, p0, None, **lk_params)
79
80          # Update bounding boxes based on optical flow and estimate velocity
81          current_time = time.time()
82          if prev_time is not None:
83              elapsed_time = current_time - prev_time
84              for i, (new, old) in enumerate(zip(p1, p0)):
85                  a, b = new.ravel()
86                  c, d = old.ravel()
87                  startX, startY, endX, endY = bbox[i]
88                  displacement_x = a - c
89                  displacement_y = b - d
90                  velocity_x = displacement_x / elapsed_time
91                  velocity_y = displacement_y / elapsed_time
92                  velocity = np.sqrt(velocity_x**2 + velocity_y**2)
93                  cv2.putText(frame, f'Velocity: {velocity:.2f} pixels/sec', (startX, startY - 30),
94                              cv2.FONT_HERSHEY_SIMPLEX, 0.5, (0, 255, 0), 2)
95
96          prev_time = current_time
97
98          # Draw updated bounding boxes
99          for i, (new, old) in enumerate(zip(p1, p0)):
100             a, b = new.ravel()
101             c, d = old.ravel()
102             startX, startY, endX, endY = bbox[i]
103             startX += int(a - c)
104             startY += int(b - d)
105             endX += int(a - c)
106             endY += int(b - d)
107             bbox[i] = (startX, startY, endX, endY)
108             cv2.rectangle(frame, (startX, startY),
109                           (endX, endY), (0, 255, 0), 2)
```

```
            cv2.putText(frame, 'tiger', (startX, startY - 10),
                        cv2.FONT_HERSHEY_SIMPLEX, 0.5, (0, 255, 0), 2)

    # Display the frame
    cv2.imshow('Frame', frame)

    # Update the previous frame and keypress handling
    old_gray = frame_gray.copy()
    key = cv2.waitKey(30) & 0xFF  # adjust the speed of video (1->30)
    if key == ord('q'):
        break

# Release video capture and close all windows
cap.release()
cv2.destroyAllWindows()
```

Result: