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Date: 13/11/2024

## Load Video

```
In [6]: import cv2
import numpy as np
from matplotlib import pyplot as plt

# Load video using OpenCV
def load_video(video_path):
    cap = cv2.VideoCapture(video_path)
    if not cap.isOpened():
        print("Error: Could not open video.")
        return None
    return cap

# Provide the path to your video file
video_path = "video1.mp4"
cap = load_video(video_path)

if cap:
    print("Video loaded successfully!")
else:
    print("Failed to load video.")
```

Video loaded successfully!

- Objective: Load the video file using OpenCV to prepare for frame-by-frame analysis.
- Steps:
  - Used cv2.VideoCapture() to load the video.
  - Checked if the video file was successfully opened.
  - Read the first frame to ensure the video is ready for processing.
- Results:
  - The video was successfully loaded and ready for further processing.
  - Printed a confirmation message if the video was loaded correctly.
- Challenges:
  - Ensuring compatibility with different video formats.
  - Handling cases where the video file might not exist or cannot be opened (e.g., incorrect file path).

## Motion Estimation

```
In [7]: # Function to calculate histogram difference between two frames
def histogram_diff(frame1, frame2):
```

```

hist1 = cv2.calcHist([frame1], [0], None, [256], [0, 256])
hist2 = cv2.calcHist([frame2], [0], None, [256], [0, 256])
return cv2.compareHist(hist1, hist2, cv2.HISTCMP_BHATTACHARYYA)

# Initialize variables
ret, prev_frame = cap.read()
prev_frame_gray = cv2.cvtColor(prev_frame, cv2.COLOR_BGR2GRAY) if ret else None

frame_count = 0
motion_regions = []

while ret:
    # Read next frame
    ret, frame = cap.read()
    if not ret:
        break

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

    # Calculate histogram difference
    hist_diff = histogram_diff(prev_frame_gray, frame_gray)

    # Frame differencing
    frame_diff = cv2.absdiff(prev_frame_gray, frame_gray)
    _, thresh = cv2.threshold(frame_diff, 30, 255, cv2.THRESH_BINARY)

    # Detect motion based on frame differencing
    motion_detected = np.sum(thresh) > 1000 # Check if motion is significant
    motion_regions.append((frame_count, hist_diff, motion_detected))

    # Update the previous frame
    prev_frame_gray = frame_gray.copy()

    frame_count += 1

cap.release()

print("Motion estimation completed.")

```

Motion estimation completed.

- Objective: Detect motion between consecutive frames using frame differencing and histogram comparison to identify regions with significant changes.
- Steps:
  - Converted each frame to grayscale for easier processing.
  - Calculated the histogram difference between consecutive frames using the Bhattacharyya distance.
  - Applied frame differencing by subtracting consecutive grayscale frames.
  - Used thresholding to highlight regions with significant pixel changes.
  - Stored the results, including frame number, histogram difference, and whether motion was detected, in a list.
- Results:
  - Successfully detected changes between consecutive frames.
  - Identified regions of motion based on frame differencing and histogram differences.

- A list of frames with detected motion was created for further analysis.
- Challenges:
  - Finding the optimal threshold values for frame differencing and histogram comparison.
  - Handling cases where subtle movements might get missed or false positives due to noise.

## Event Detection

```
In [8]: # Function to detect significant events
def detect_events(motion_data, hist_threshold=0.8):
    events = []
    for frame_num, hist_diff, motion_detected in motion_data:
        if hist_diff > hist_threshold or motion_detected:
            events.append(frame_num)
    return events

# Detect events based on the histogram threshold and motion detection
events_detected = detect_events(motion_regions, hist_threshold=0.8)

print(f"Detected {len(events_detected)} significant events:")
print(events_detected)
```

Detected 233 significant events:

```
[1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 2
3, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 4
3, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 6
3, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 76, 77, 78, 79, 80, 81, 82, 83, 8
4, 85, 87, 88, 89, 90, 91, 92, 93, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 1
05, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 12
2, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 13
8, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 15
4, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 17
0, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 18
6, 187, 188, 189, 190, 191, 192, 193, 195, 196, 197, 198, 199, 200, 201, 202, 20
3, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 21
9, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 23
5, 236, 237, 238]
```

- Objective: Detect significant motion events based on the intensity of changes detected in motion estimation.
- Steps:
  - Defined a function to analyze motion data and detect significant events.
  - Events were detected based on two criteria:
    - Histogram difference: Frames with histogram differences above a specified threshold.
    - Frame differencing: Frames with significant pixel changes.
- Collected the frame numbers of all detected events.
- Results:
  - Detected a list of frames where significant motion or events occurred.
  - Printed the frame numbers for easy reference.
  - Detected events were stored in a list for visualization.

- Challenges:
  - Balancing sensitivity to ensure important events are detected while minimizing false positives.
  - Defining a suitable threshold for what constitutes a "significant" event.

## Result

```
In [9]: # Reload the video to visualize events
cap = load_video(video_path)
if not cap:
    print("Failed to reload video for visualization.")

frame_count = 0

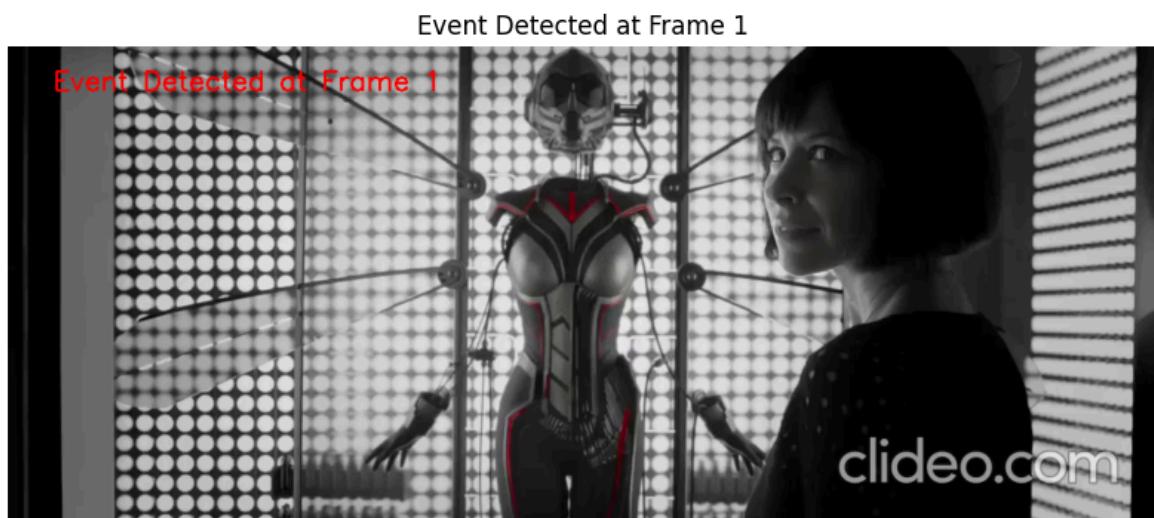
while cap.isOpened():
    ret, frame = cap.read()
    if not ret:
        break

    # Check if the current frame is an event frame
    if frame_count in events_detected:
        cv2.putText(frame, f"Event Detected at Frame {frame_count}", (50, 50),
                   cv2.FONT_HERSHEY_SIMPLEX, 1, (0, 0, 255), 2)

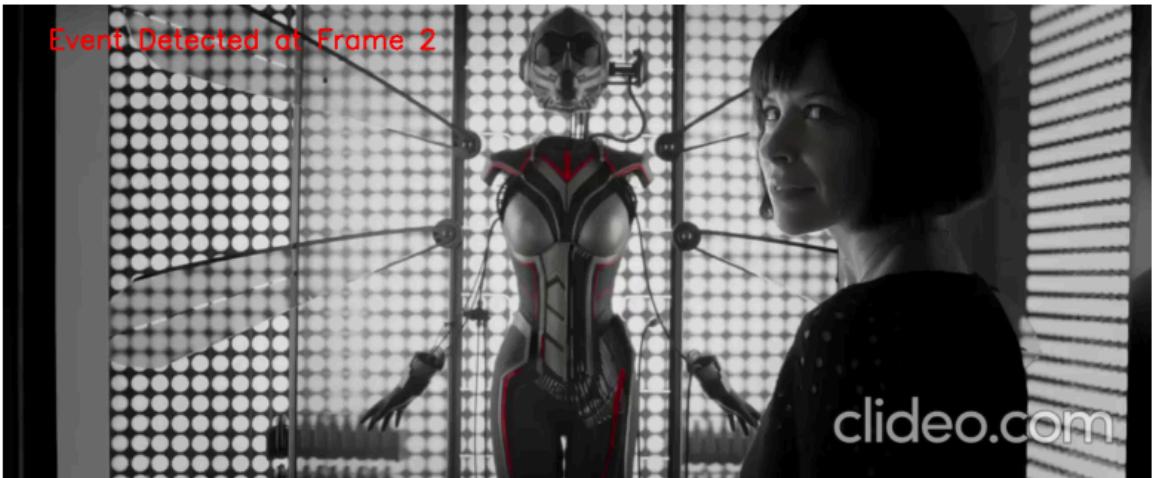
    # Display the frame with event annotation
    plt.figure(figsize=(10, 6))
    plt.imshow(cv2.cvtColor(frame, cv2.COLOR_BGR2RGB))
    plt.title(f"Event Detected at Frame {frame_count}")
    plt.axis('off')
    plt.show()

    frame_count += 1

cap.release()
print("Visualization complete.")
```



Event Detected at Frame 2



Event Detected at Frame 3



Event Detected at Frame 4



Event Detected at Frame 5



Event Detected at Frame 6



Event Detected at Frame 7



Event Detected at Frame 8



Event Detected at Frame 9



Event Detected at Frame 10



Event Detected at Frame 11



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Event Detected at Frame 12



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Event Detected at Frame 13

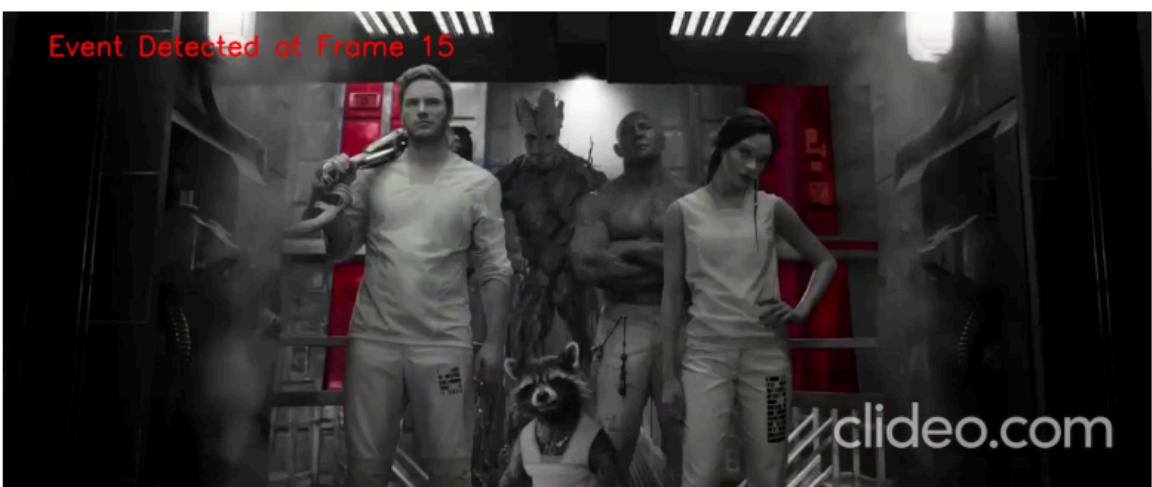


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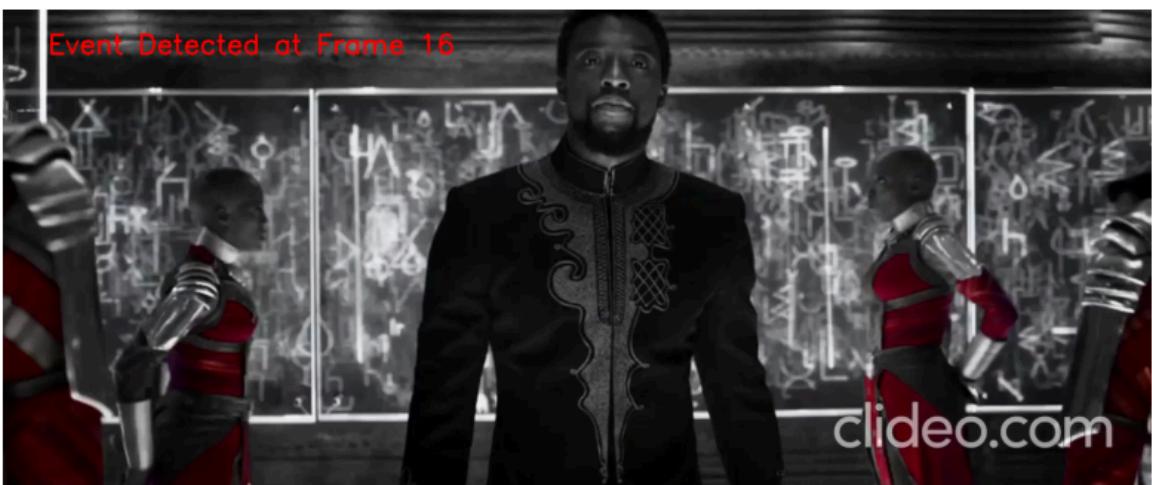
Event Detected at Frame 14



Event Detected at Frame 15



Event Detected at Frame 16



Event Detected at Frame 17



Event Detected at Frame 18



Event Detected at Frame 19



Event Detected at Frame 20



Event Detected at Frame 21



Event Detected at Frame 22



Event Detected at Frame 23

Event Detected at Frame 23



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Event Detected at Frame 24

Event Detected at Frame 24



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Event Detected at Frame 25

Event Detected at Frame 25



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Event Detected at Frame 26

Event Detected at Frame 26



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Event Detected at Frame 27

Event Detected at Frame 27



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Event Detected at Frame 28

Event Detected at Frame 28



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Event Detected at Frame 29

Event Detected at Frame 29



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Event Detected at Frame 30

Event Detected at Frame 30



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Event Detected at Frame 31

Event Detected at Frame 31



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Event Detected at Frame 32

Event Detected at Frame 32



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Event Detected at Frame 49

Event Detected at Frame 49



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Event Detected at Frame 50

Event Detected at Frame 50



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Event Detected at Frame 51

Event Detected at Frame 51



STUDIOS

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Event Detected at Frame 52

Event Detected at Frame 52



STUDIOS

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Event Detected at Frame 53

Event Detected at Frame 53



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Event Detected at Frame 54

Event Detected at Frame 54



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Event Detected at Frame 55

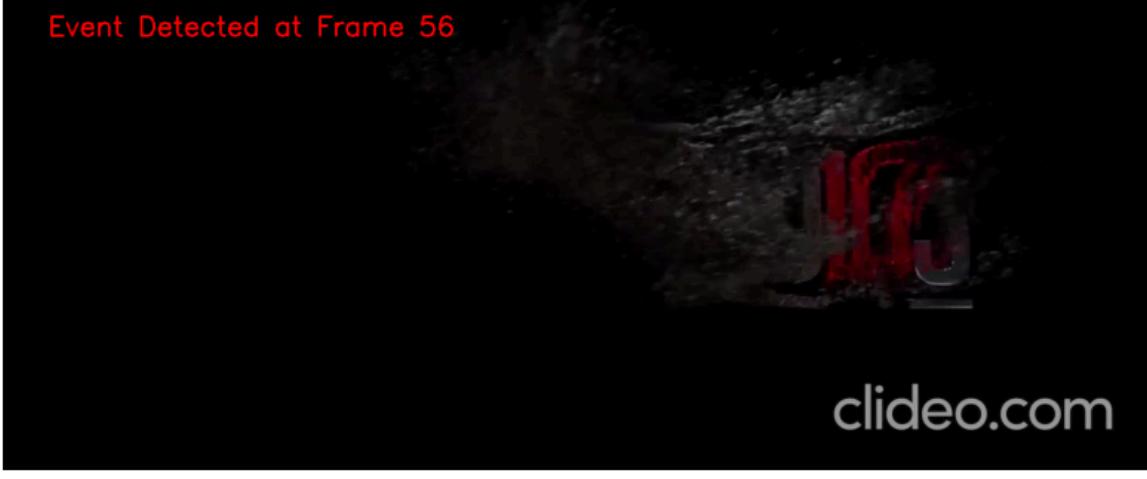
Event Detected at Frame 55



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Event Detected at Frame 56

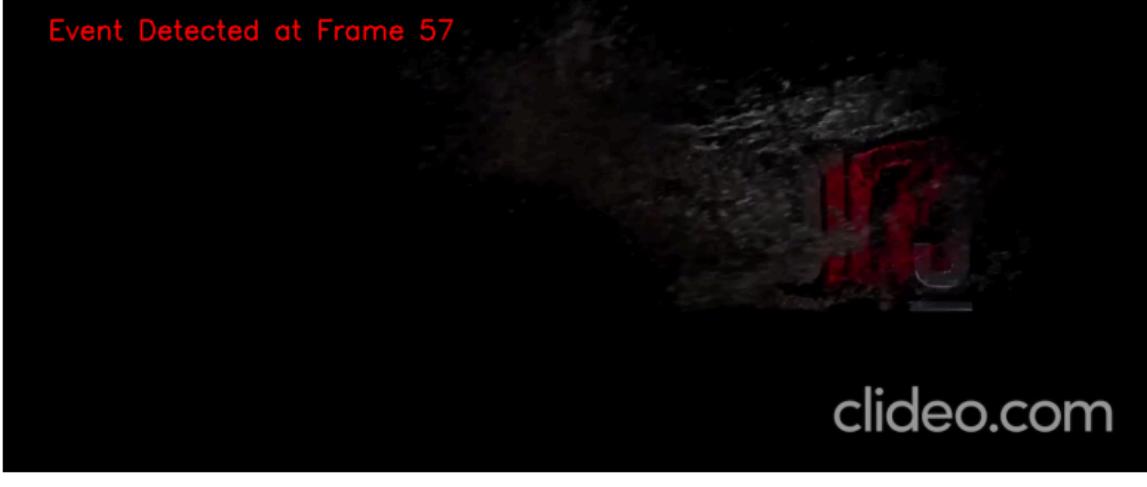
Event Detected at Frame 56



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Event Detected at Frame 57

Event Detected at Frame 57



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Event Detected at Frame 58

Event Detected at Frame 58



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Event Detected at Frame 59

Event Detected at Frame 59



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Event Detected at Frame 60

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Event Detected at Frame 61

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Event Detected at Frame 62

Event Detected at Frame 62



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Event Detected at Frame 63



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Event Detected at Frame 64

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Event Detected at Frame 65

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Event Detected at Frame 66

Event Detected at Frame 66



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Event Detected at Frame 67

Event Detected at Frame 67



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Event Detected at Frame 68

Event Detected at Frame 68



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Event Detected at Frame 69

Event Detected at Frame 69



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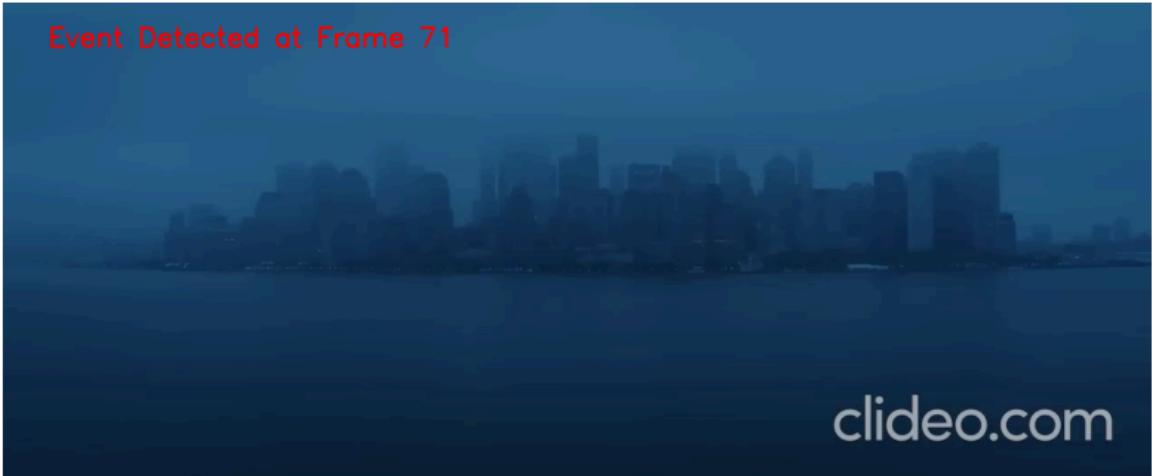
Event Detected at Frame 70

Event Detected at Frame 70

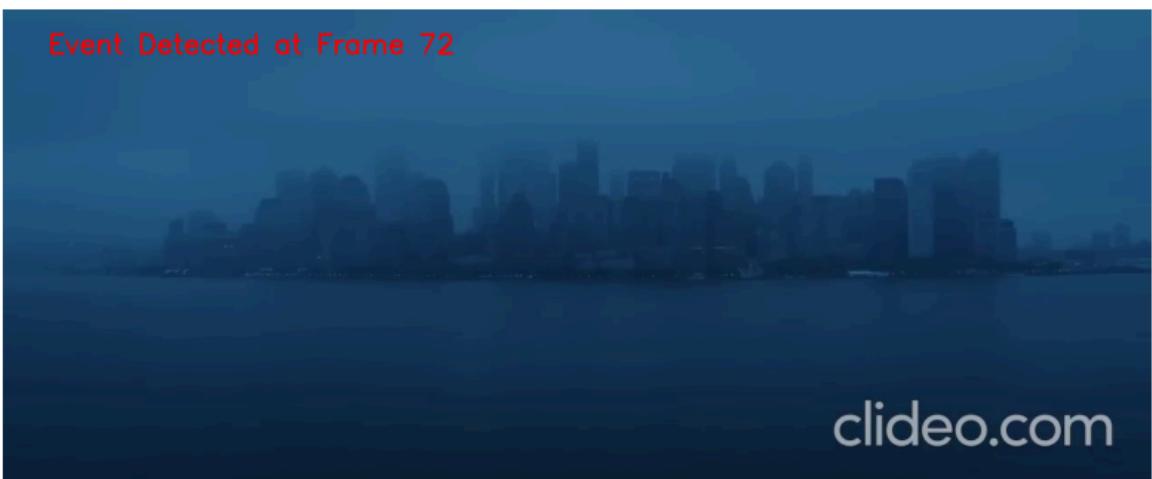


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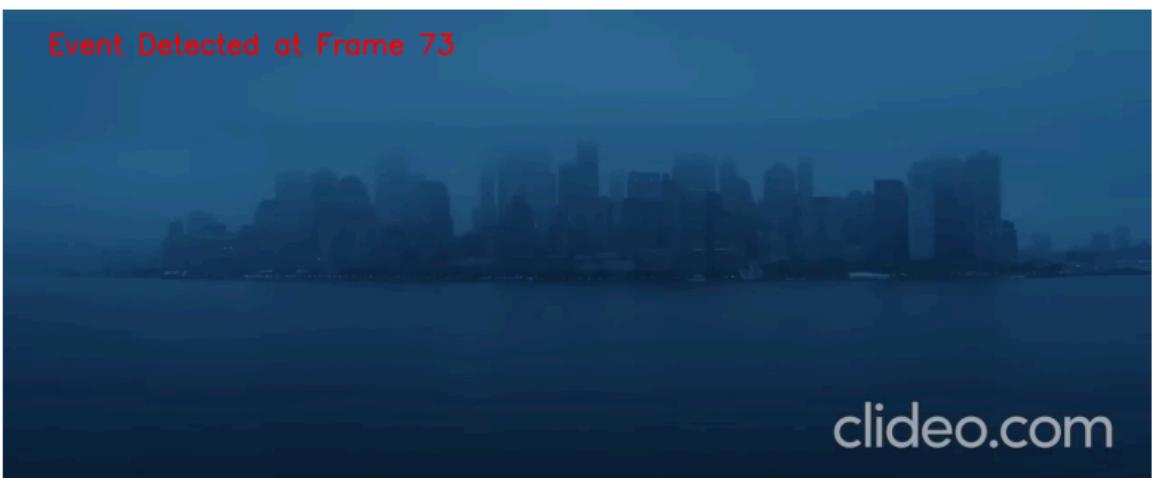
Event Detected at Frame 71



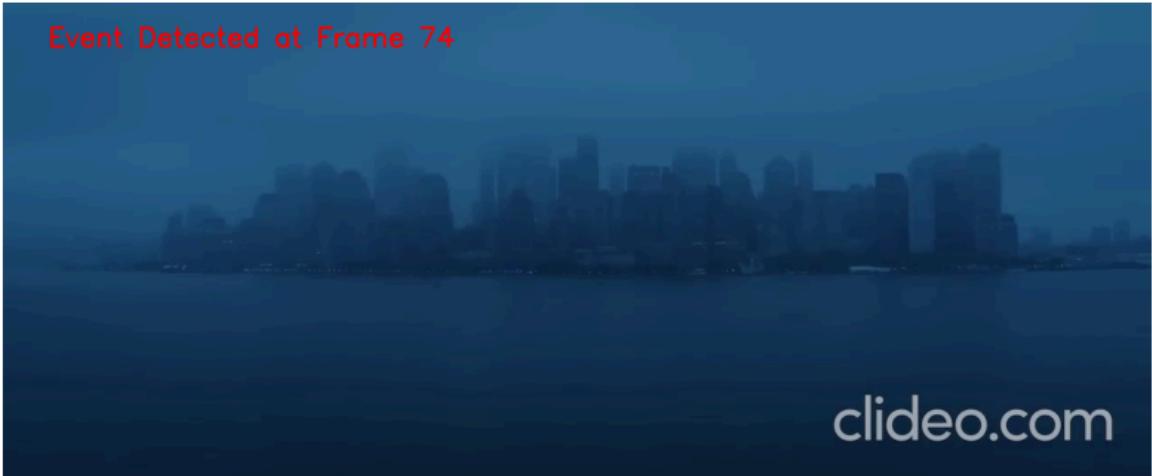
Event Detected at Frame 72



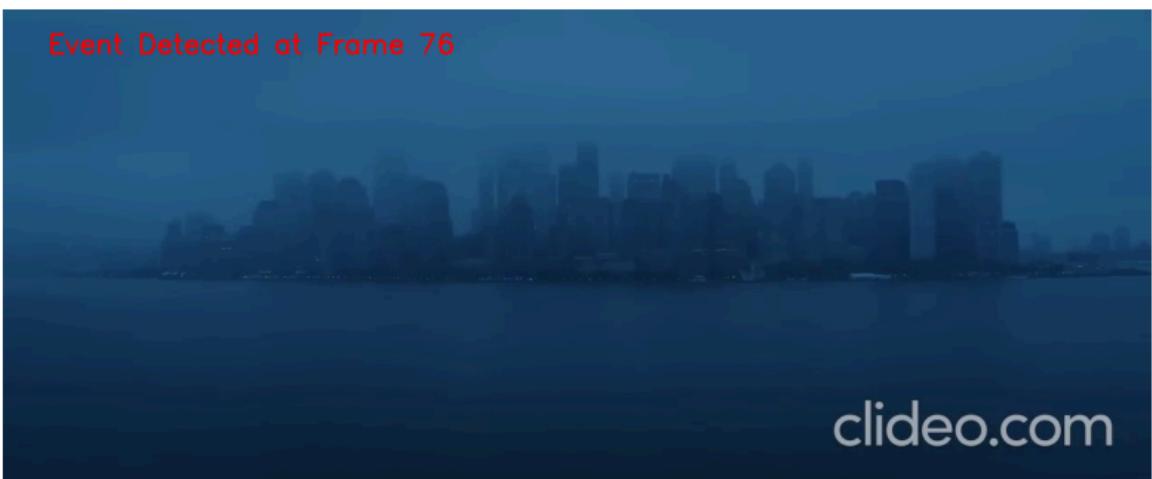
Event Detected at Frame 73



Event Detected at Frame 74



Event Detected at Frame 76



Event Detected at Frame 77

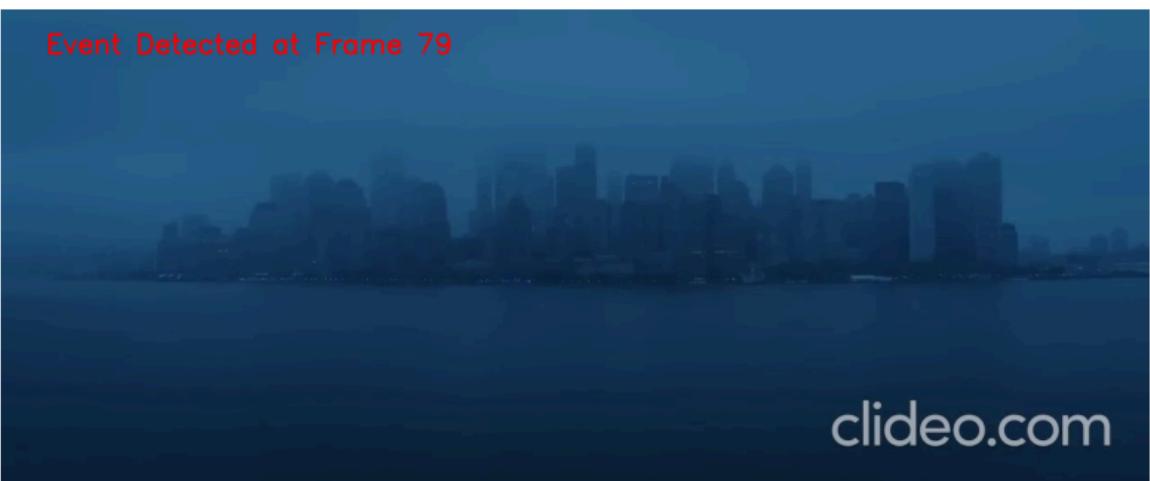


Event Detected at Frame 78



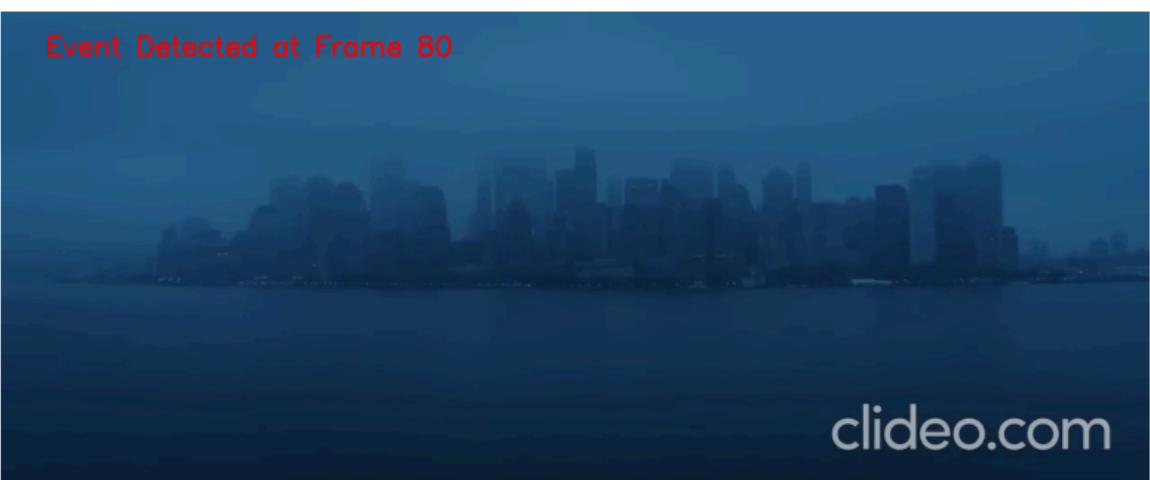
clideo.com

Event Detected at Frame 79



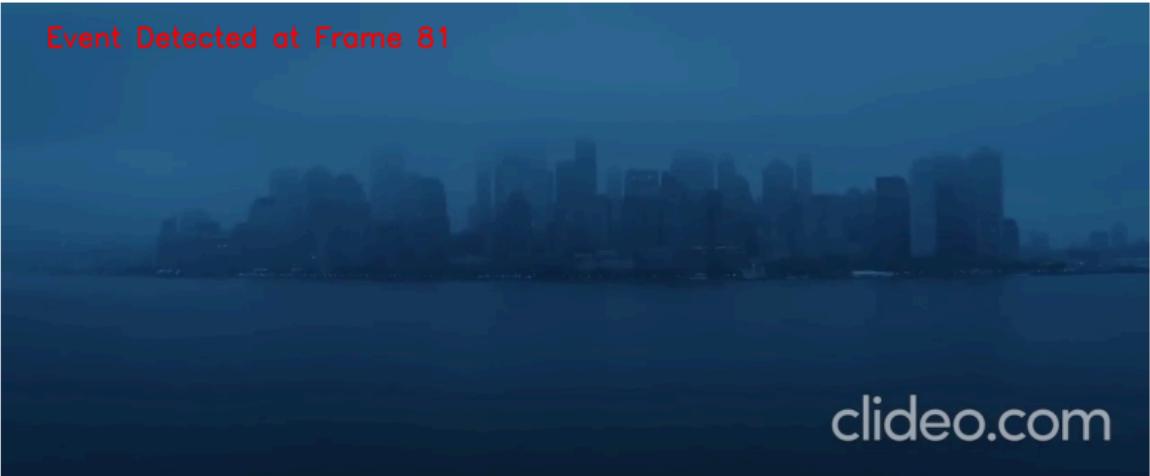
clideo.com

Event Detected at Frame 80



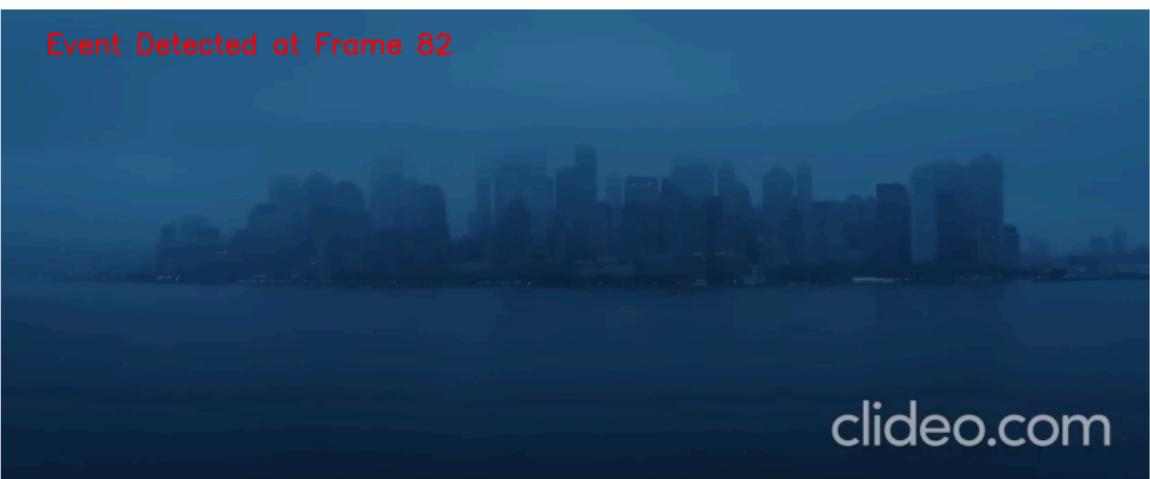
clideo.com

Event Detected at Frame 81



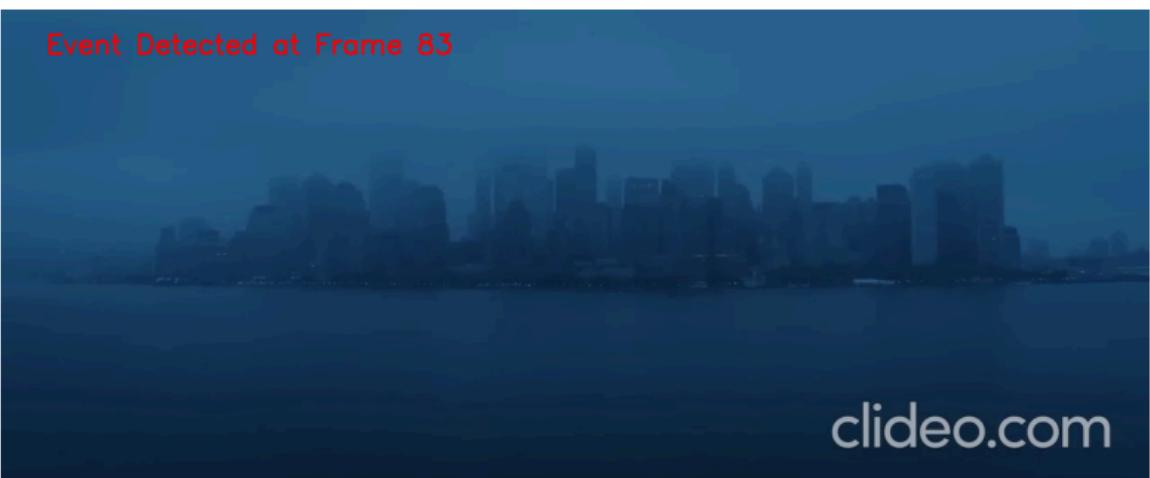
clideo.com

Event Detected at Frame 82



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Event Detected at Frame 83



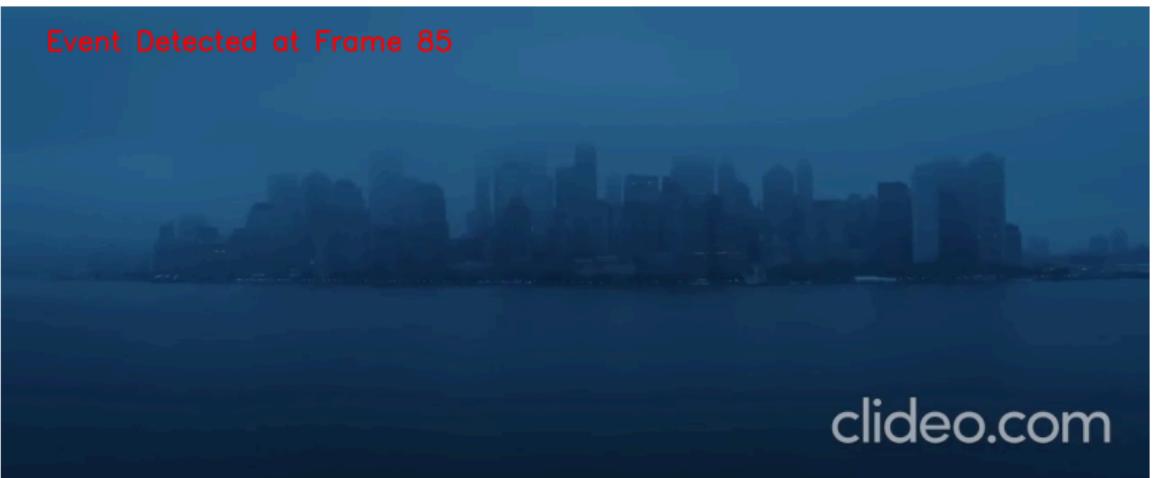
clideo.com

Event Detected at Frame 84



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Event Detected at Frame 85



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Event Detected at Frame 87



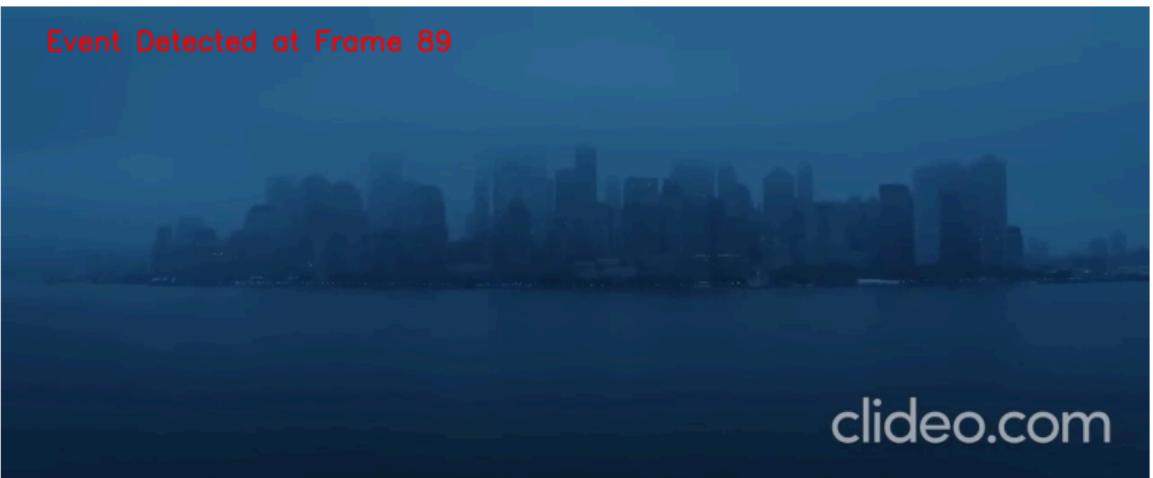
clideo.com

Event Detected at Frame 88



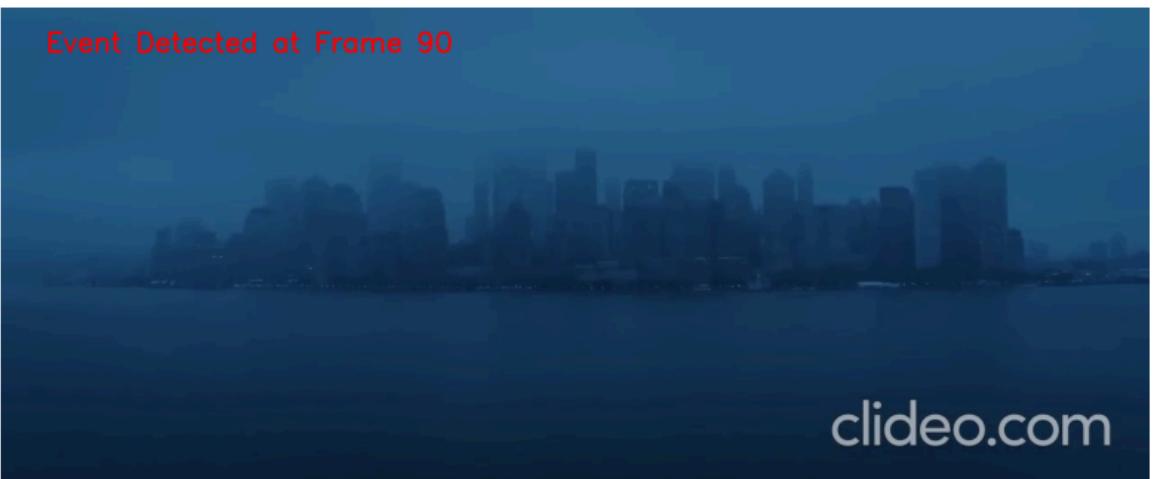
clideo.com

Event Detected at Frame 89



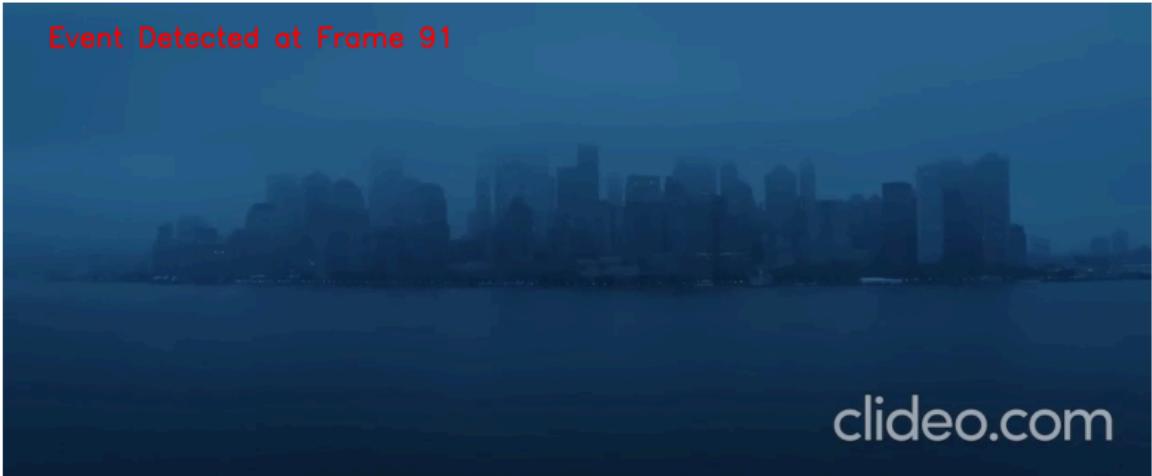
clideo.com

Event Detected at Frame 90



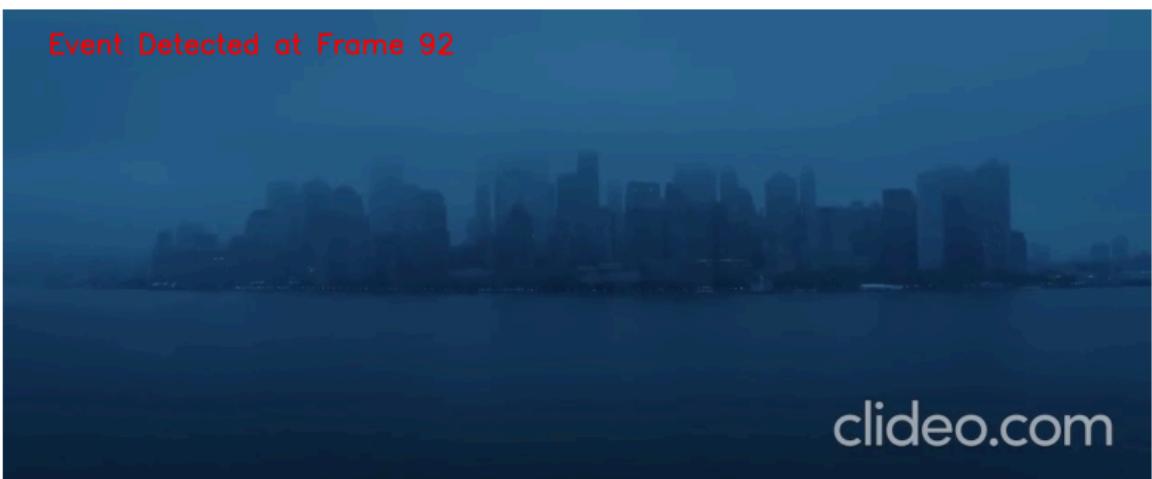
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Event Detected at Frame 91



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Event Detected at Frame 92



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Event Detected at Frame 93



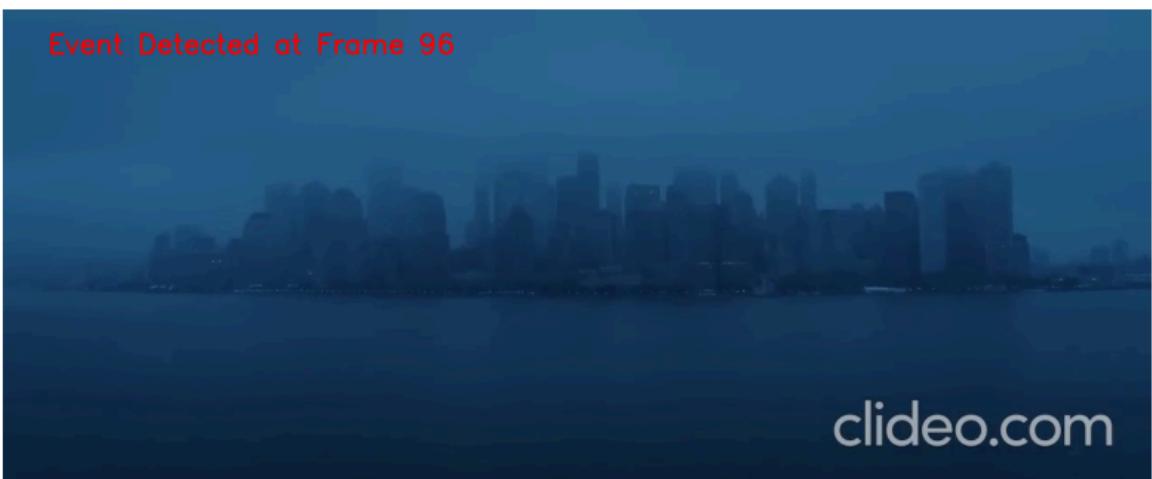
clideo.com

Event Detected at Frame 95



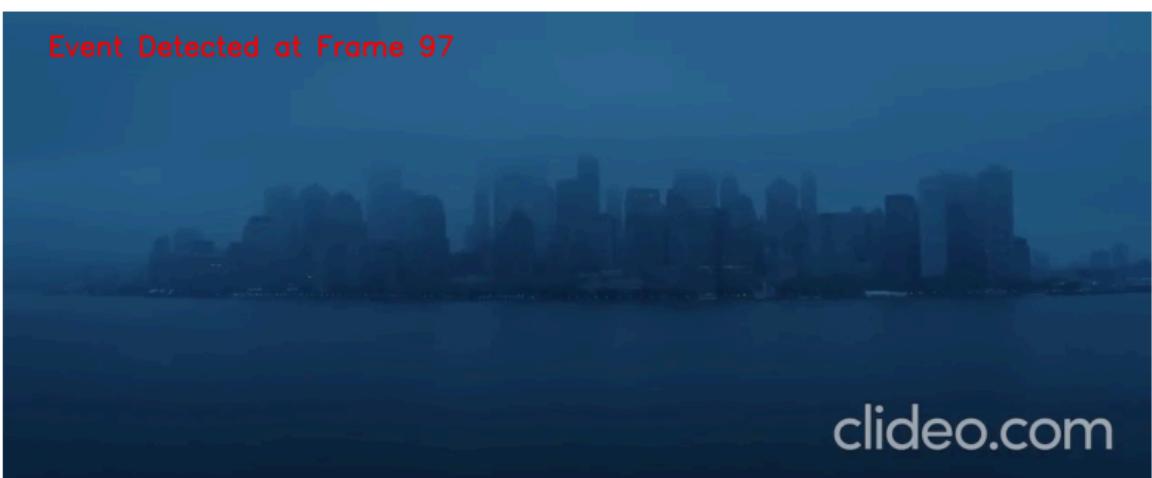
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Event Detected at Frame 96



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Event Detected at Frame 97

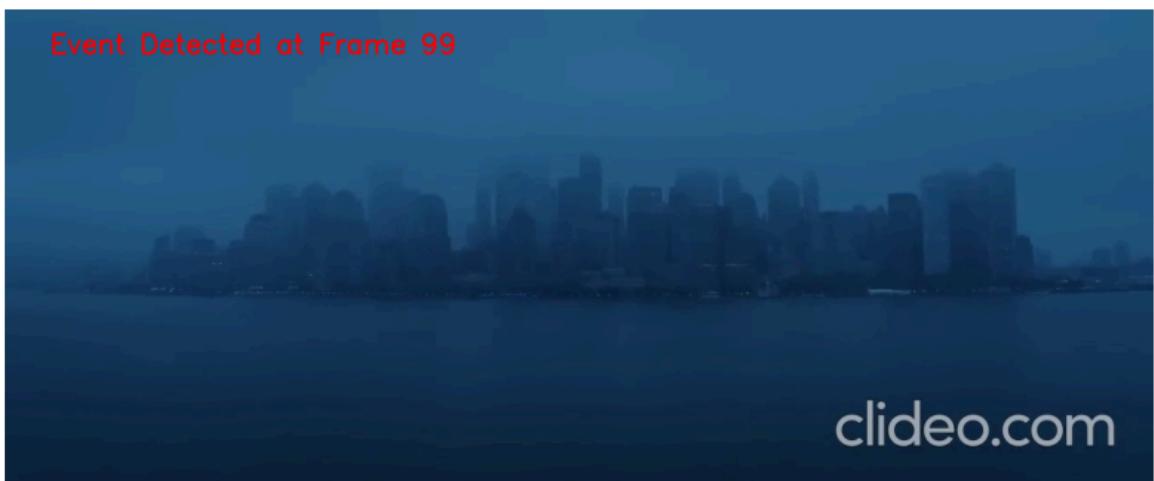


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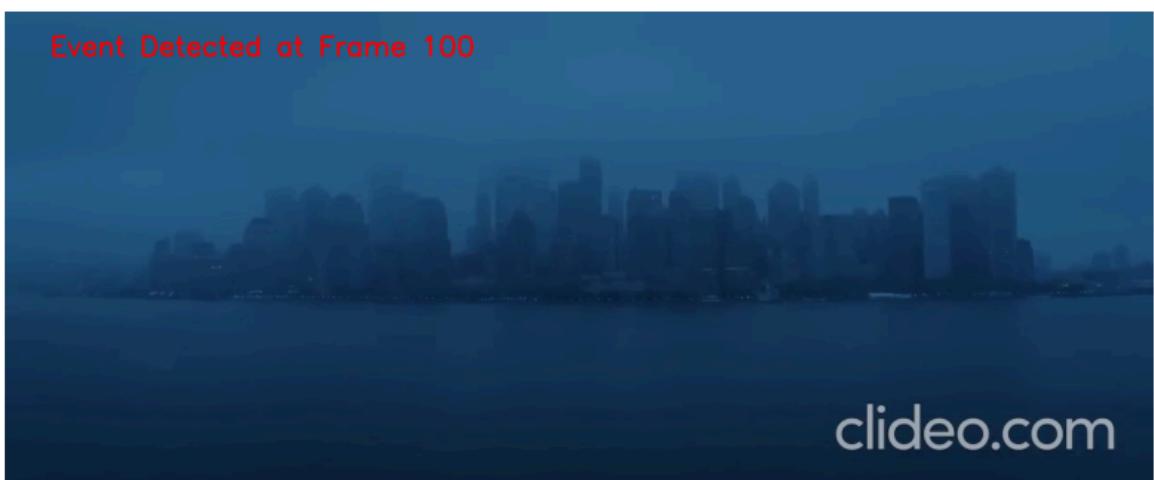
Event Detected at Frame 98



Event Detected at Frame 99



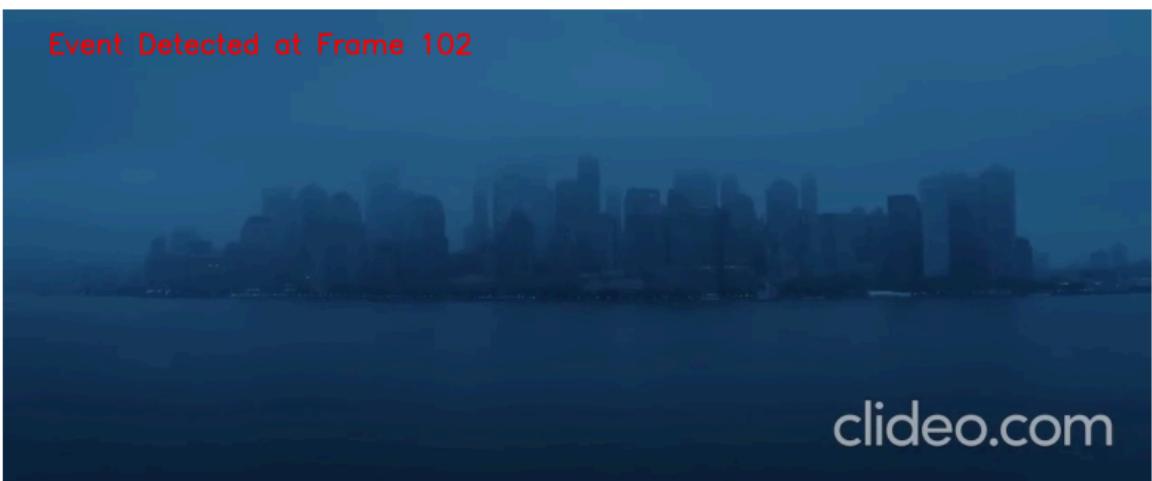
Event Detected at Frame 100



Event Detected at Frame 101



Event Detected at Frame 102



Event Detected at Frame 103

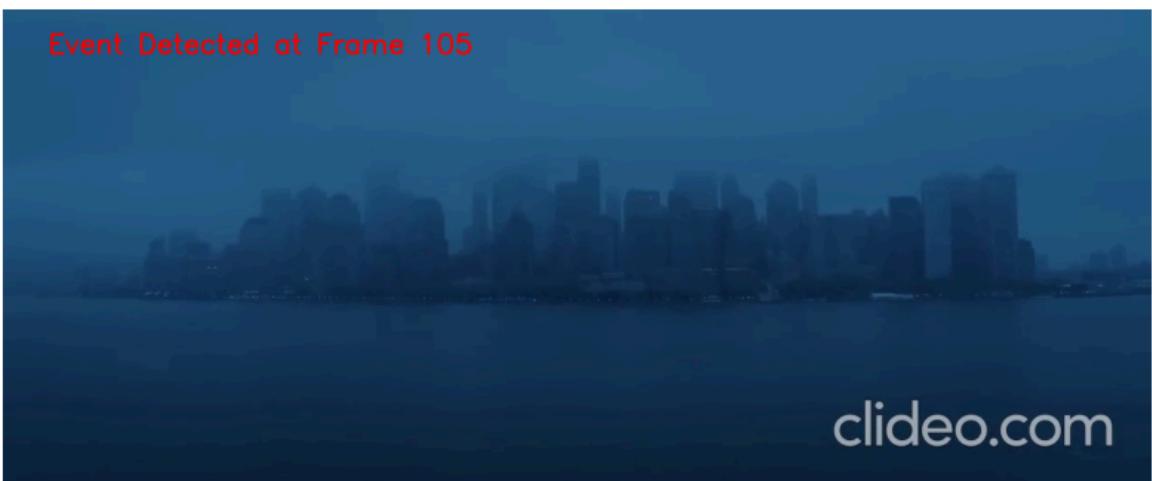


Event Detected at Frame 104



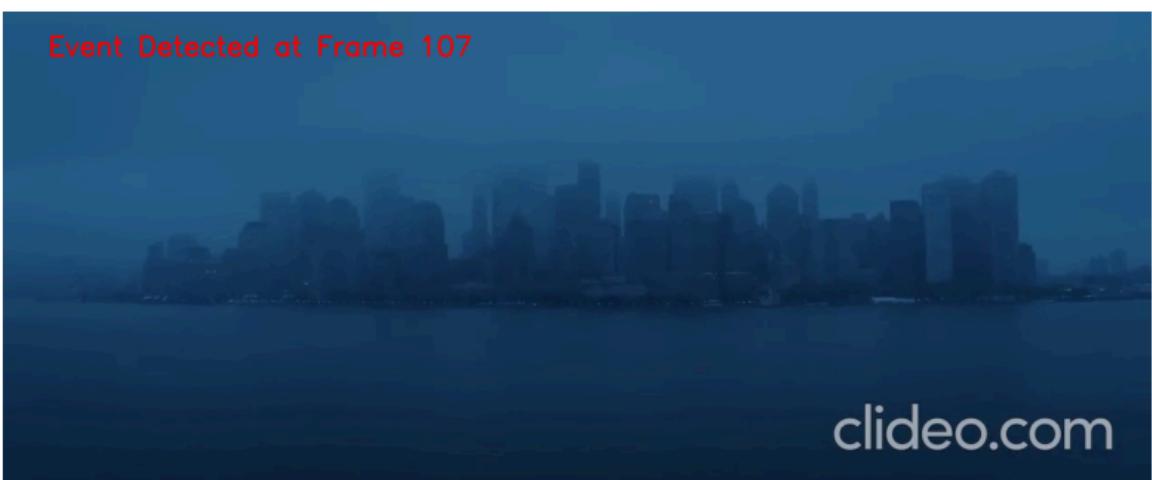
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Event Detected at Frame 105



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Event Detected at Frame 107



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Event Detected at Frame 108



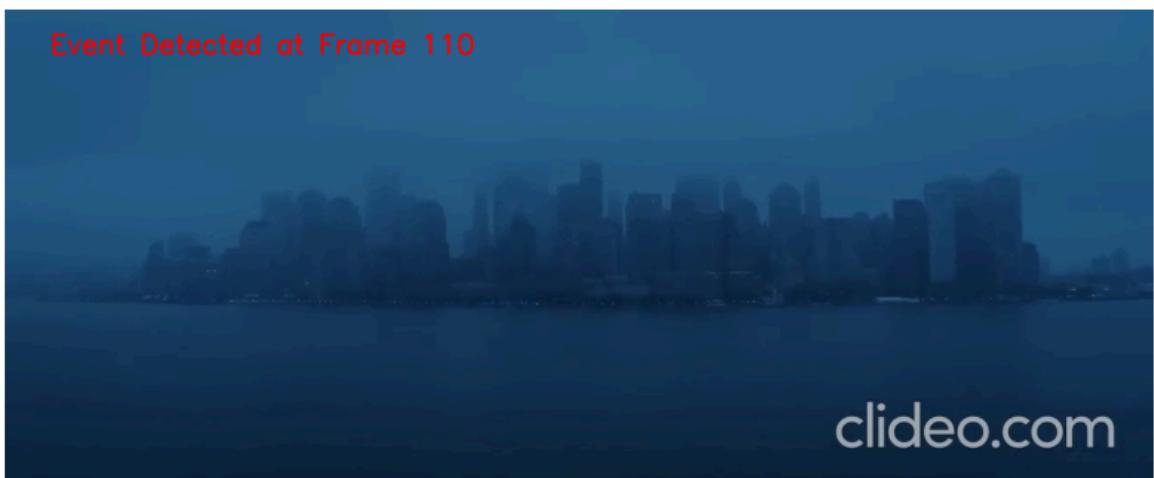
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Event Detected at Frame 109



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Event Detected at Frame 110

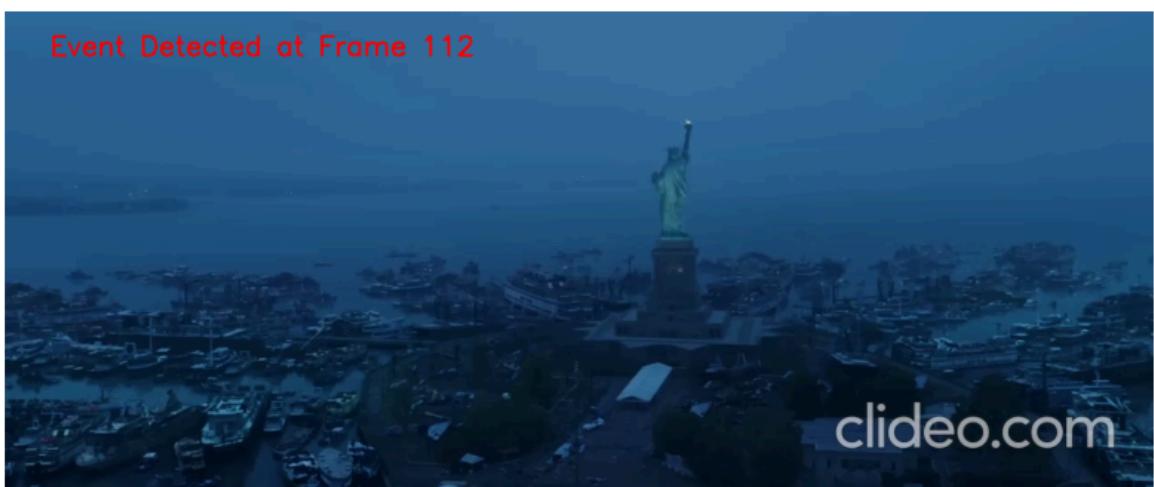


clideo.com

Event Detected at Frame 111



Event Detected at Frame 112



Event Detected at Frame 113

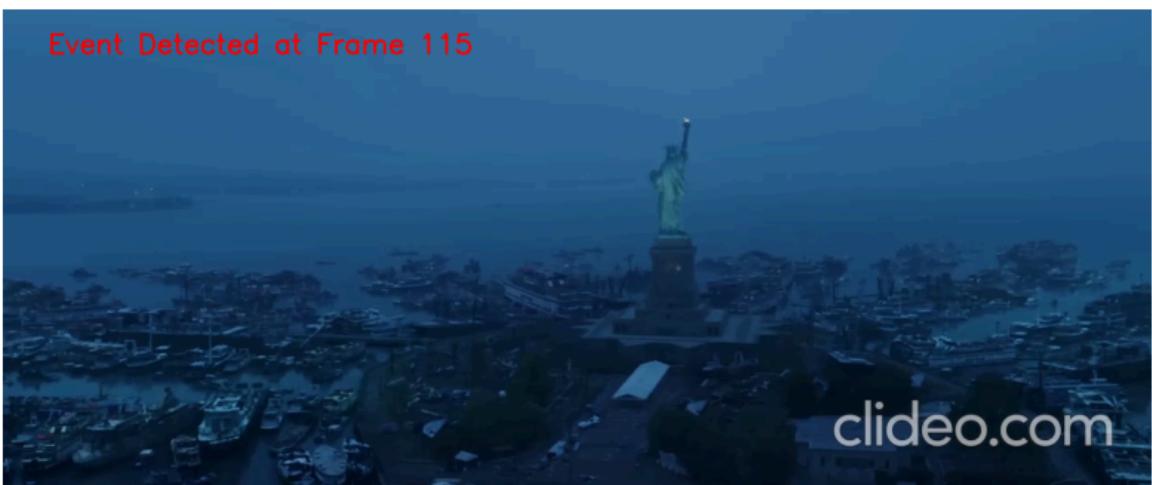


Event Detected at Frame 114



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Event Detected at Frame 115



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Event Detected at Frame 116



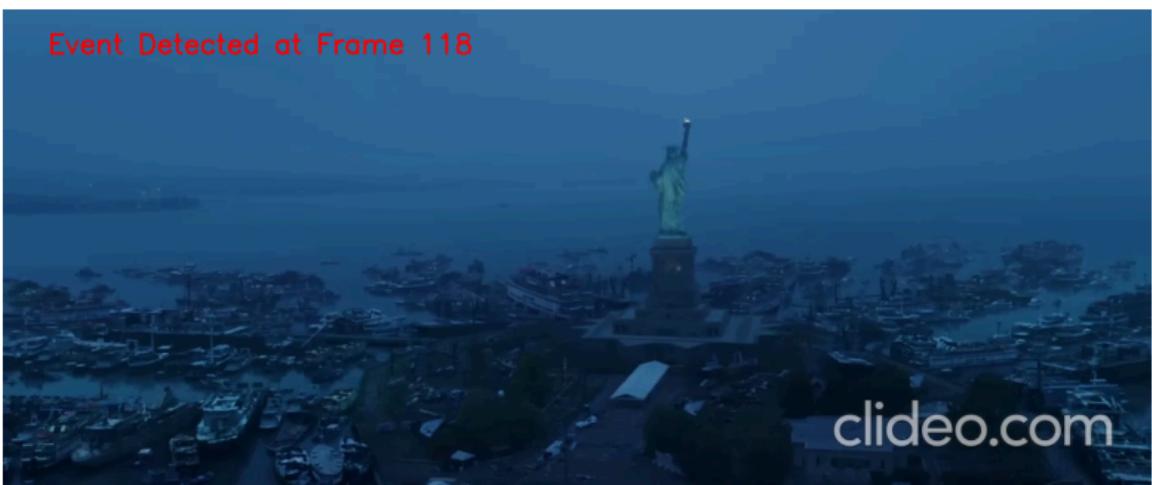
clideo.com

Event Detected at Frame 117



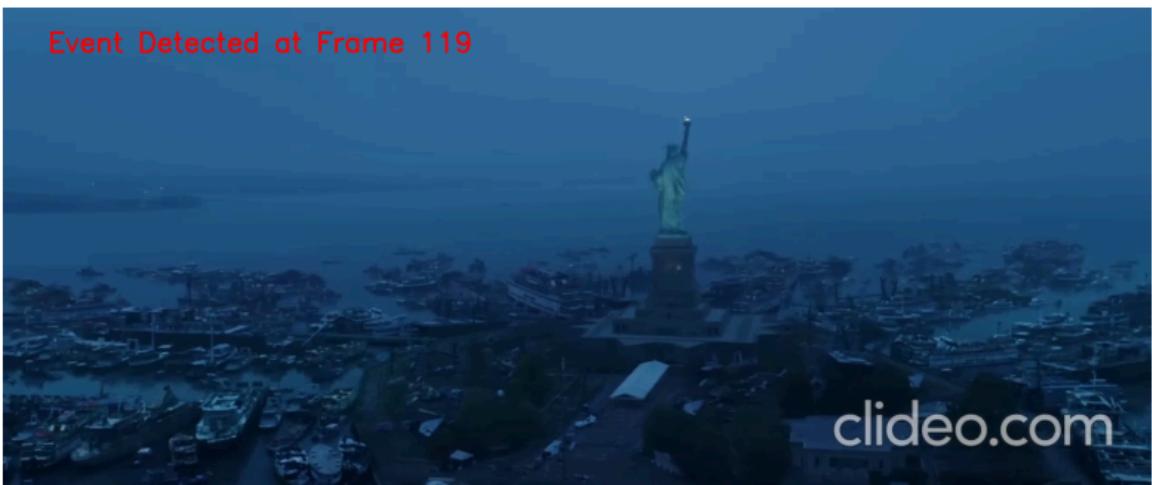
clideo.com

Event Detected at Frame 118



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Event Detected at Frame 119



clideo.com

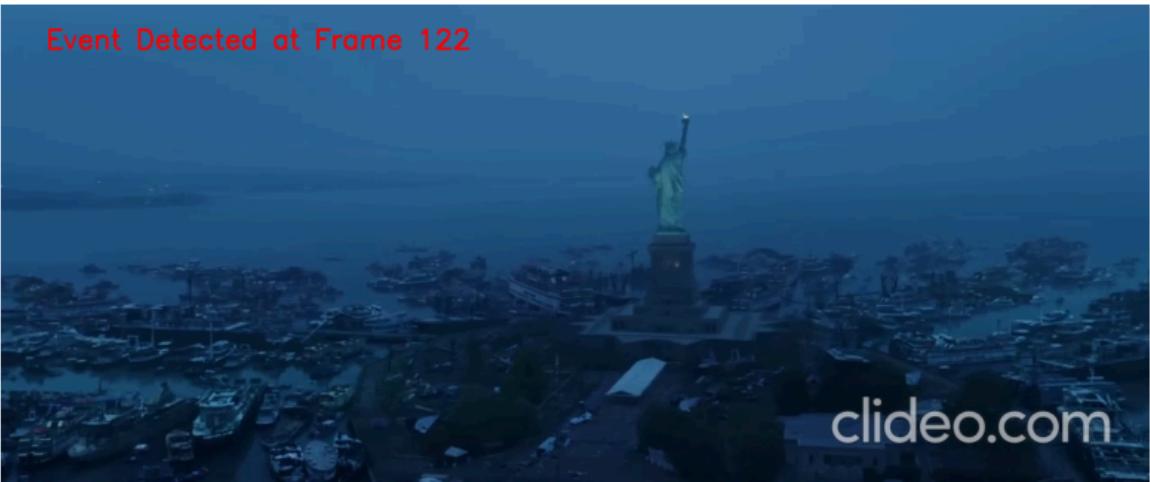
Event Detected at Frame 120



Event Detected at Frame 121



Event Detected at Frame 122

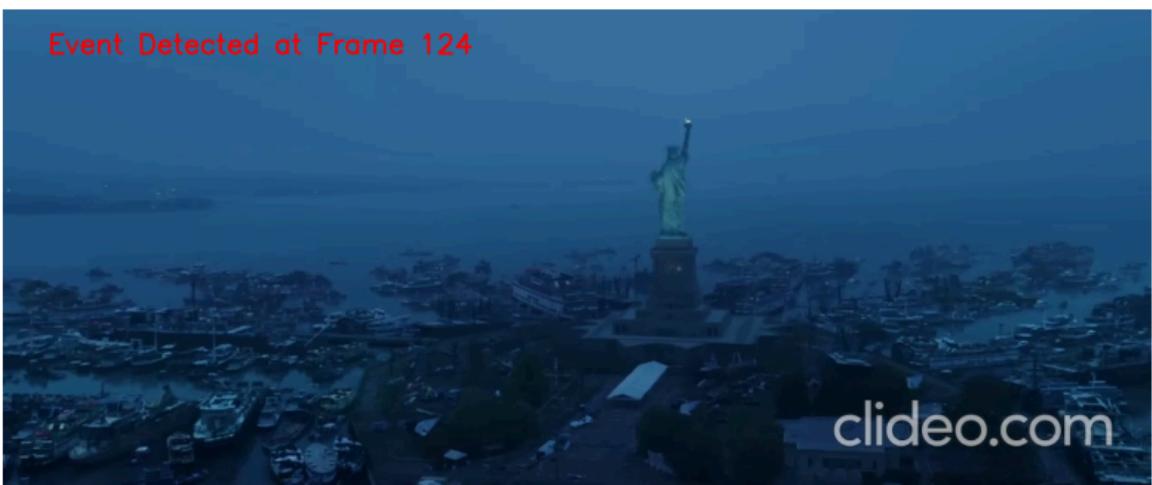


Event Detected at Frame 123



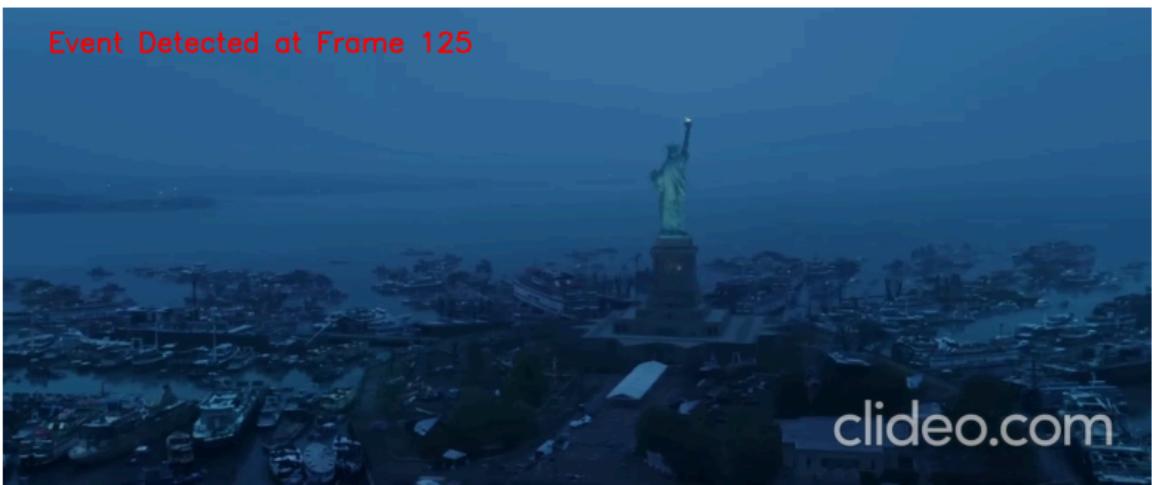
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Event Detected at Frame 124



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Event Detected at Frame 125

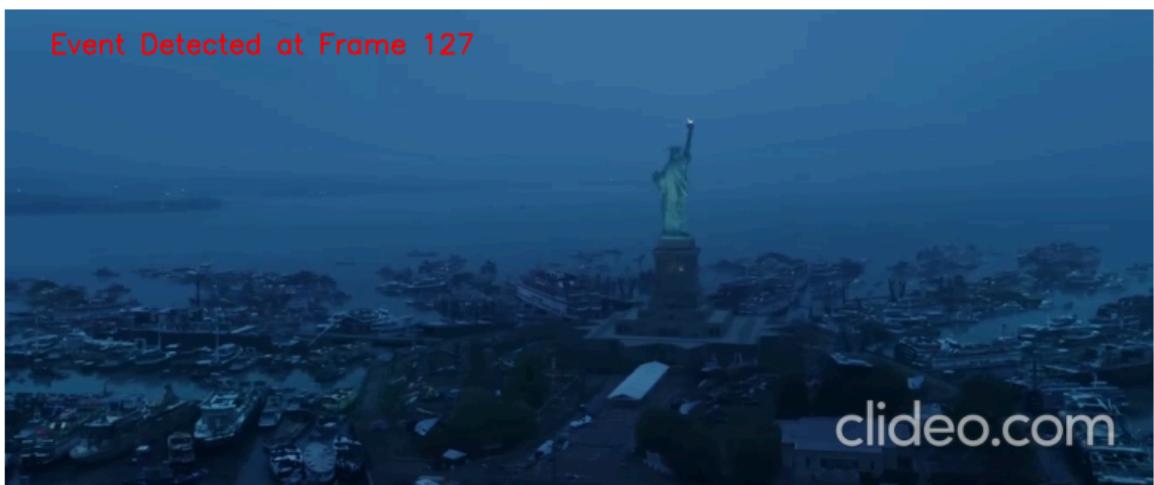


clideo.com

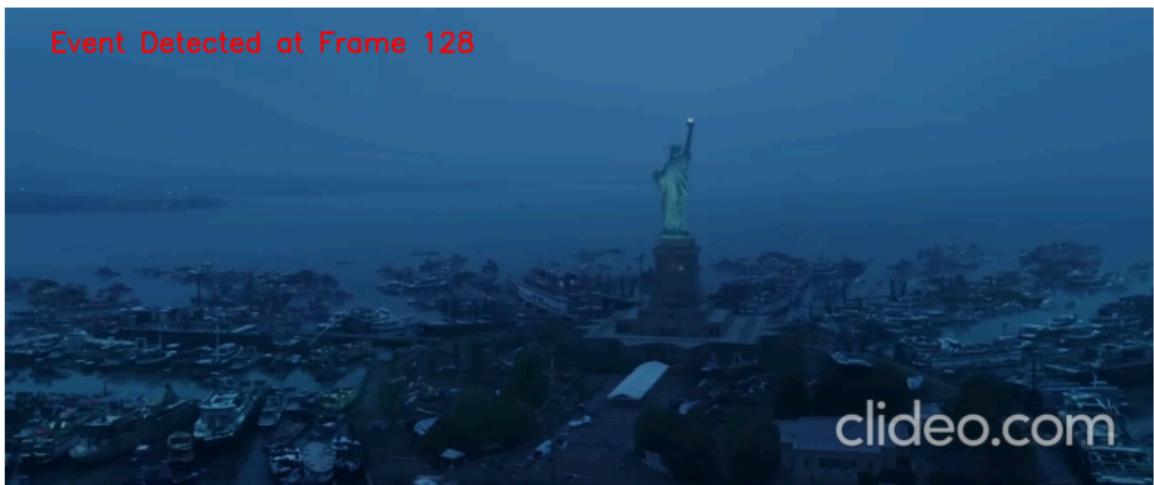
Event Detected at Frame 126



Event Detected at Frame 127



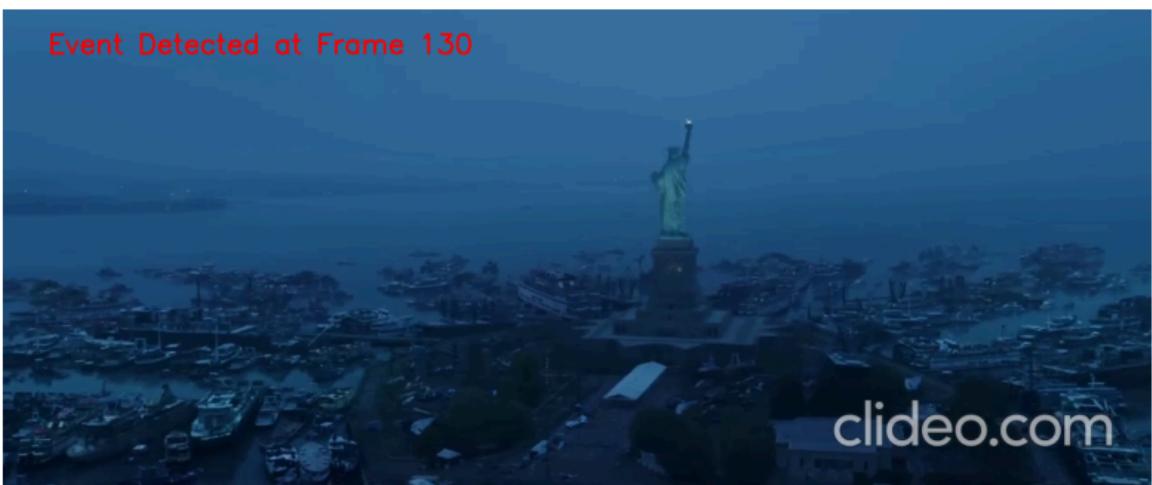
Event Detected at Frame 128



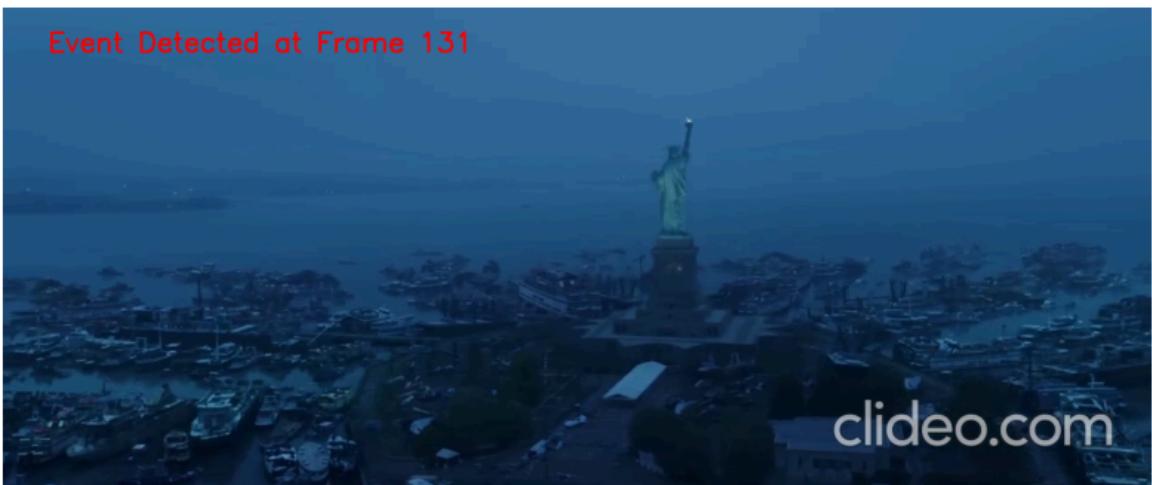
Event Detected at Frame 129



Event Detected at Frame 130



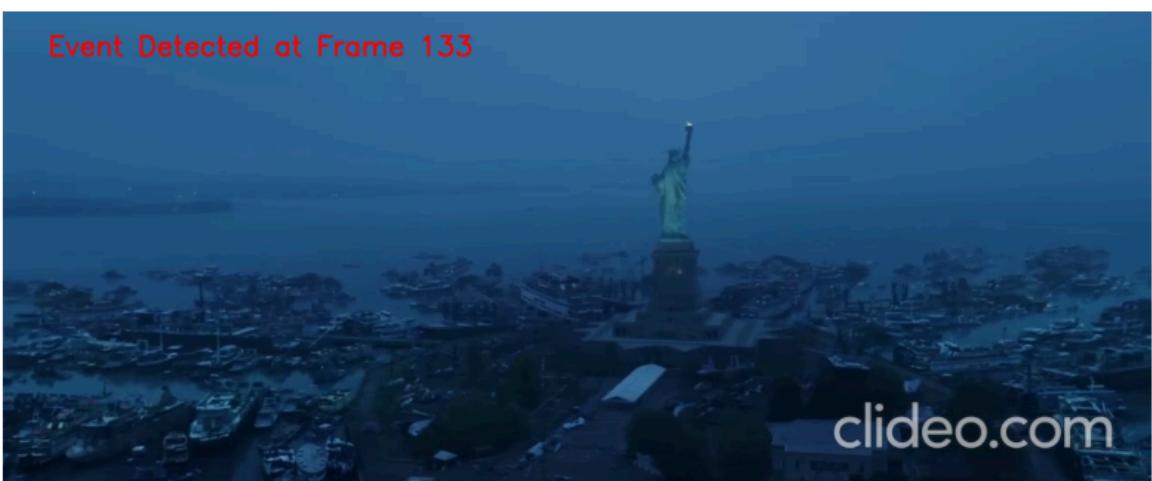
Event Detected at Frame 131



Event Detected at Frame 132



Event Detected at Frame 133



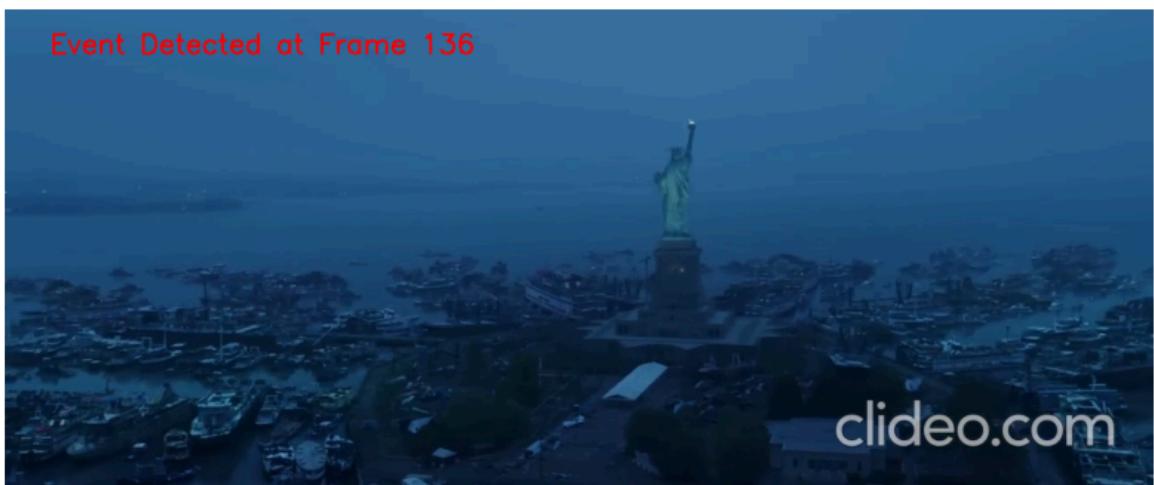
Event Detected at Frame 134



Event Detected at Frame 135



Event Detected at Frame 136



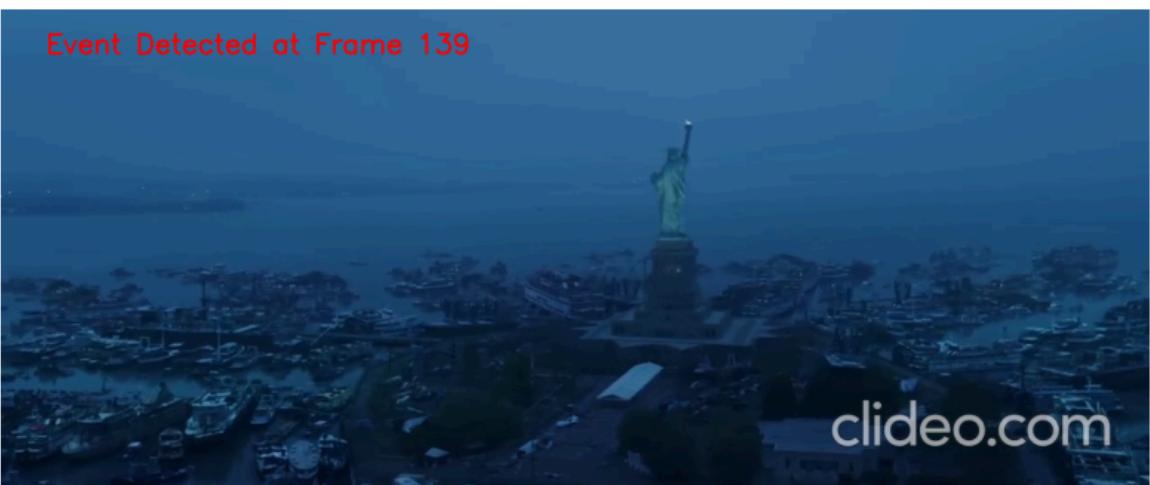
Event Detected at Frame 137



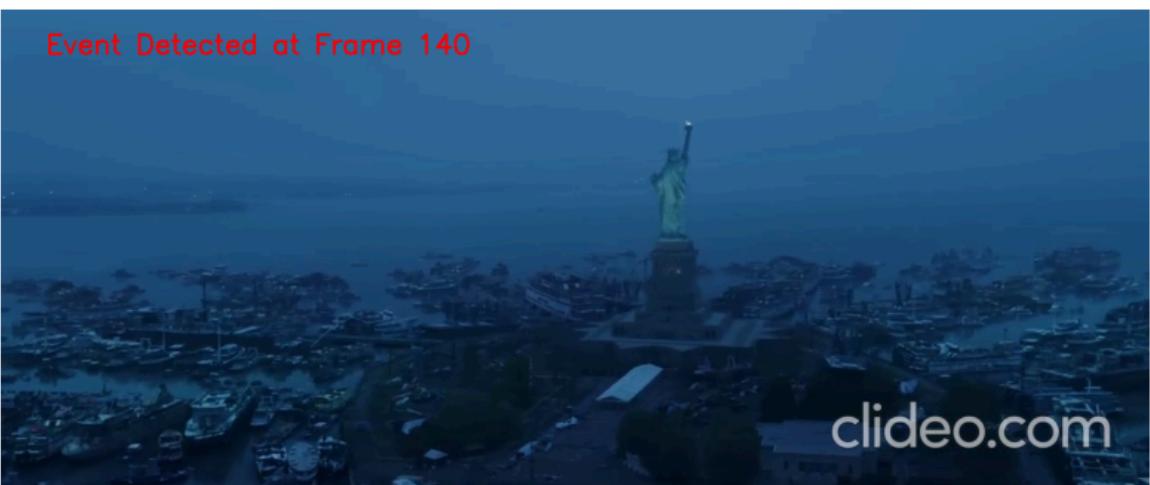
Event Detected at Frame 138



Event Detected at Frame 139



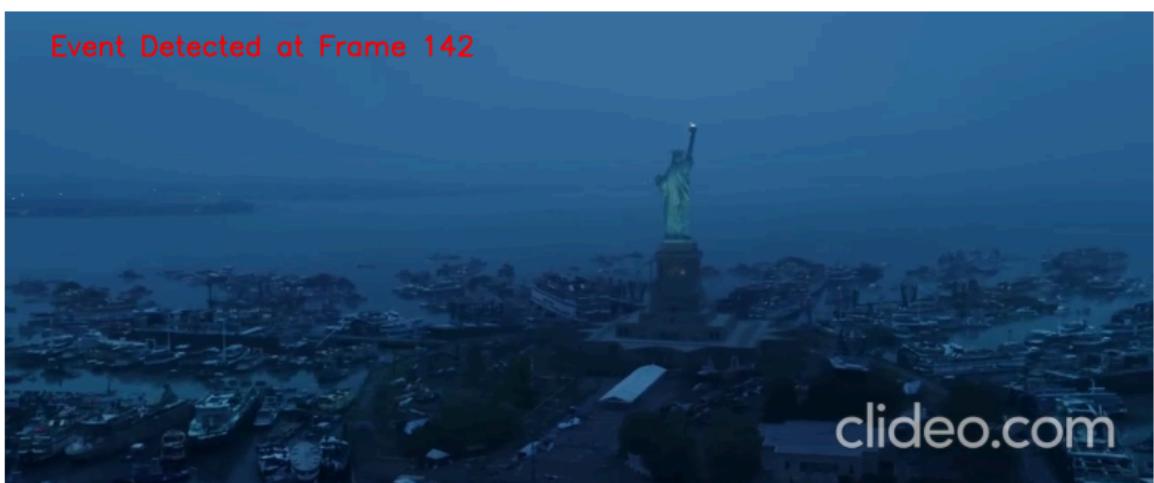
Event Detected at Frame 140



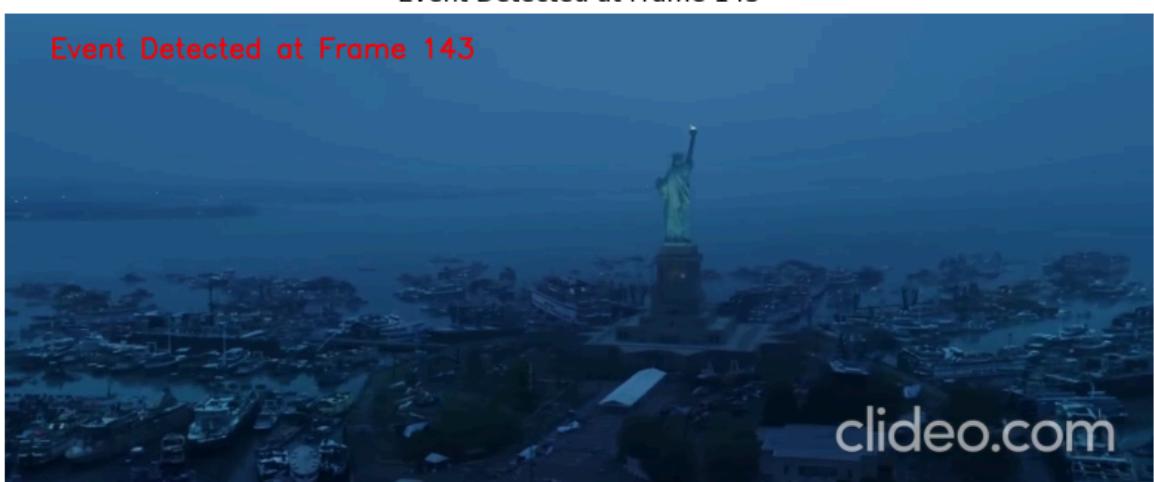
Event Detected at Frame 141



Event Detected at Frame 142



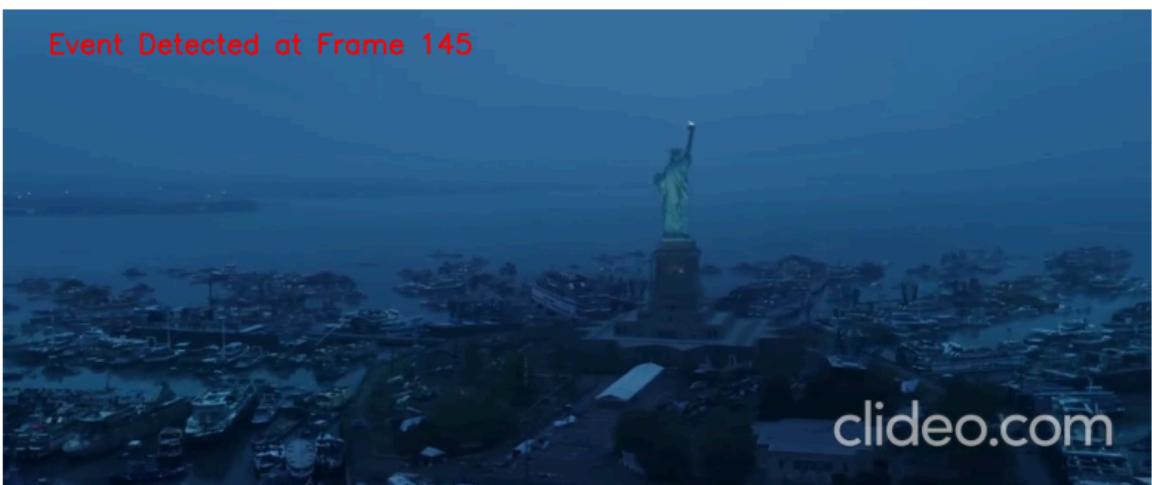
Event Detected at Frame 143



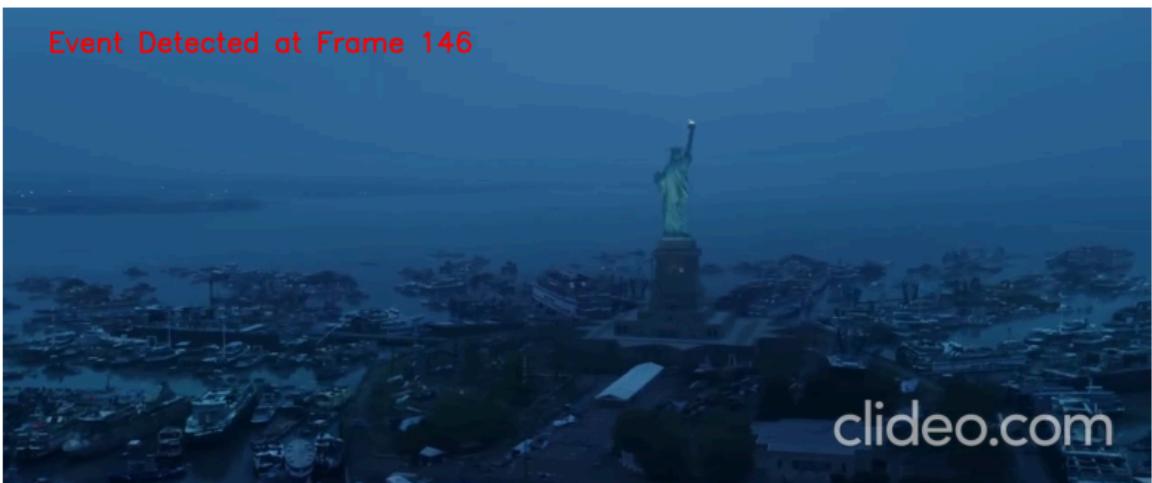
Event Detected at Frame 144



Event Detected at Frame 145



Event Detected at Frame 146

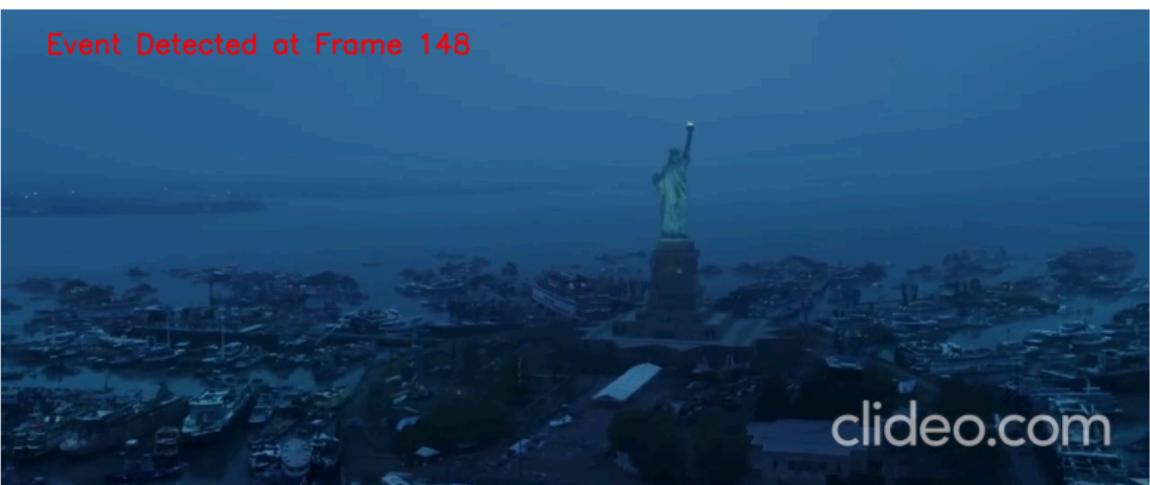


Event Detected at Frame 147



clideo.com

Event Detected at Frame 148



clideo.com

Event Detected at Frame 149

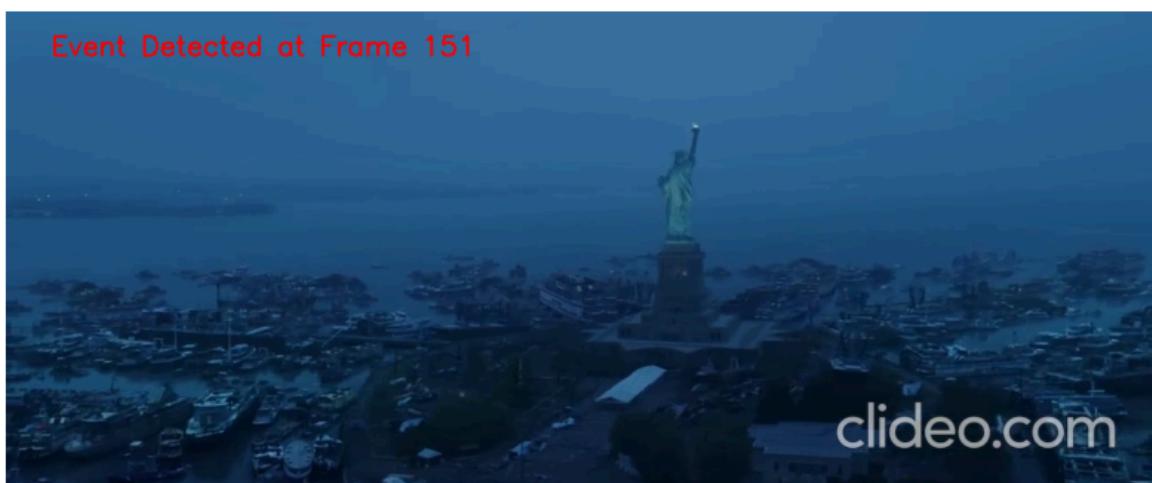


clideo.com

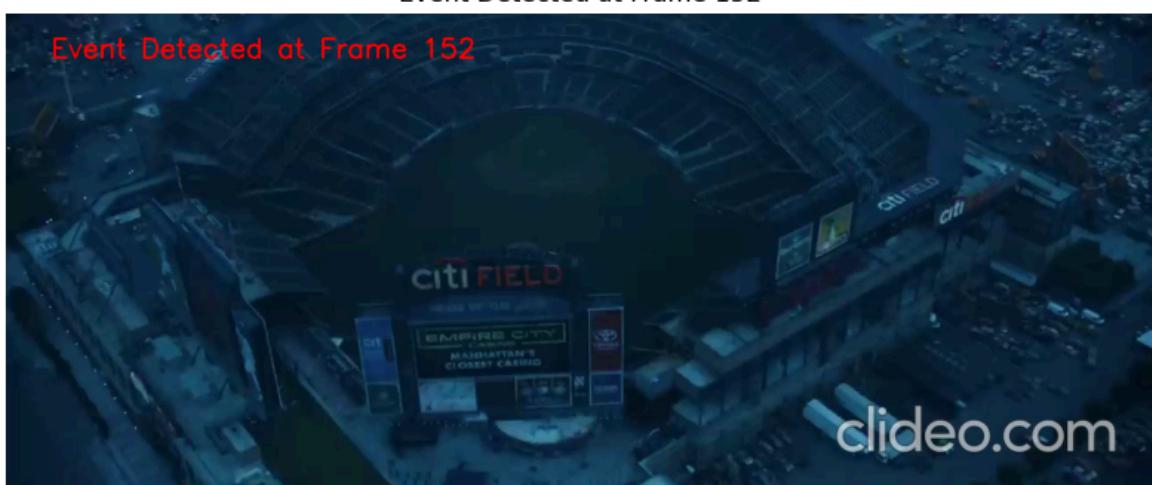
Event Detected at Frame 150



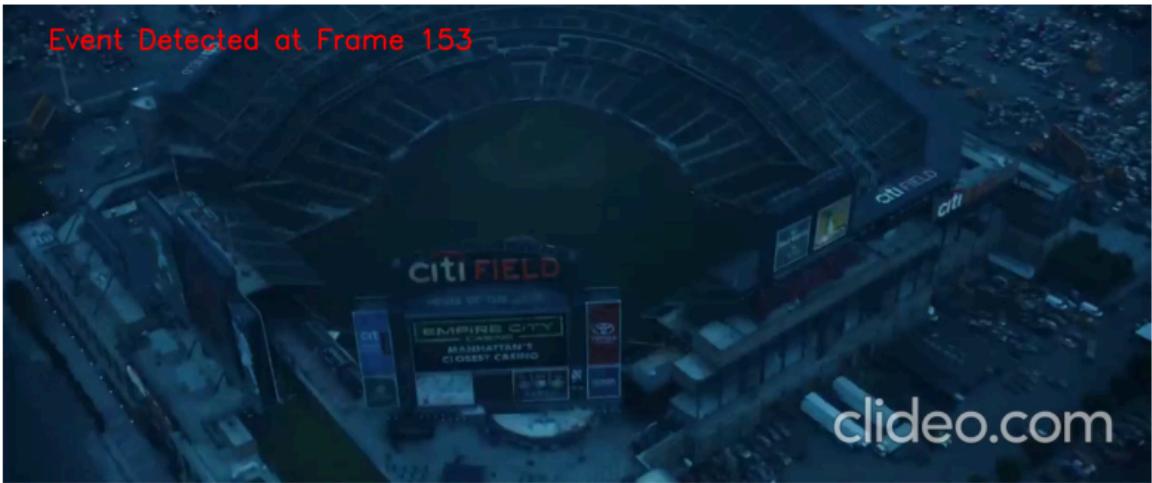
Event Detected at Frame 151



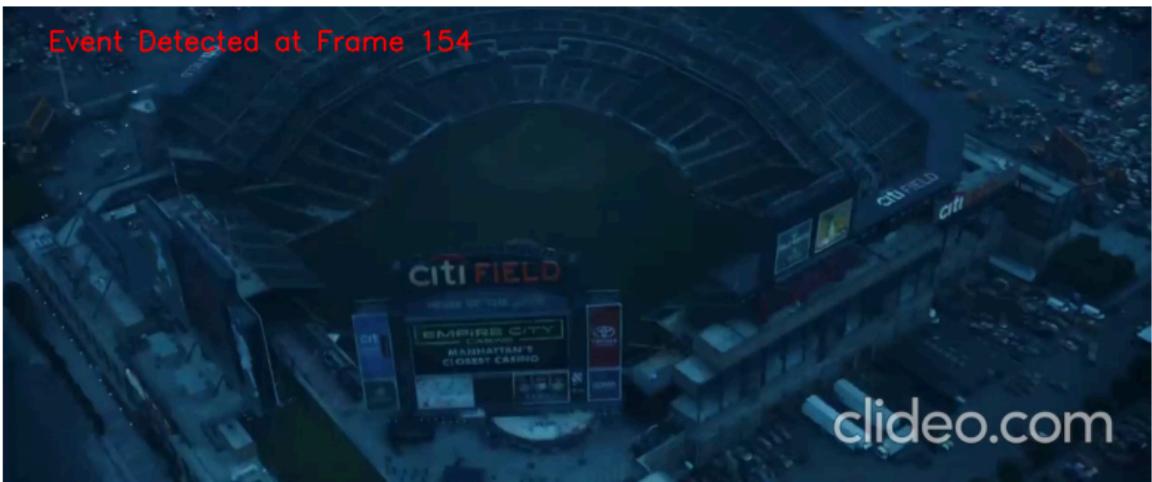
Event Detected at Frame 152



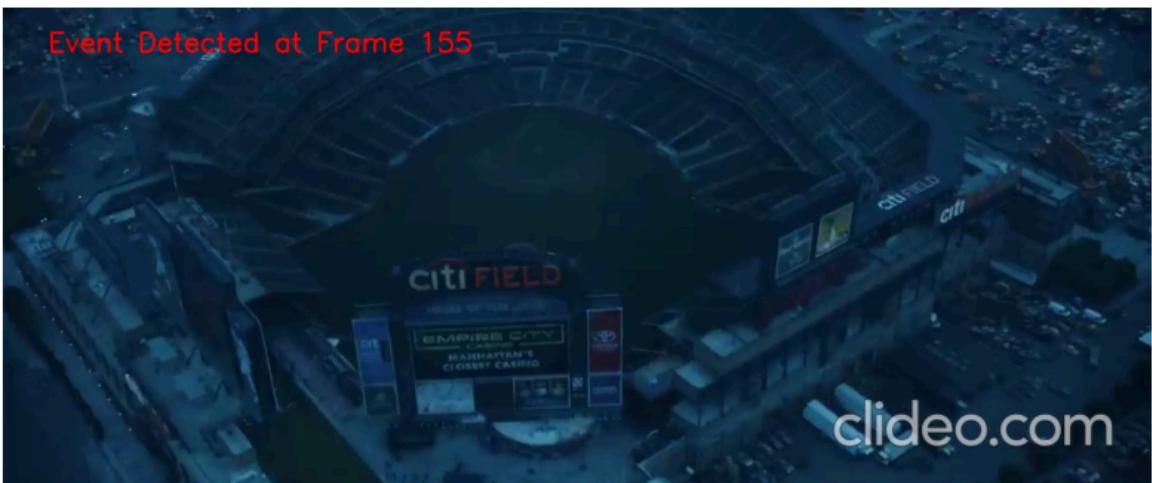
Event Detected at Frame 153



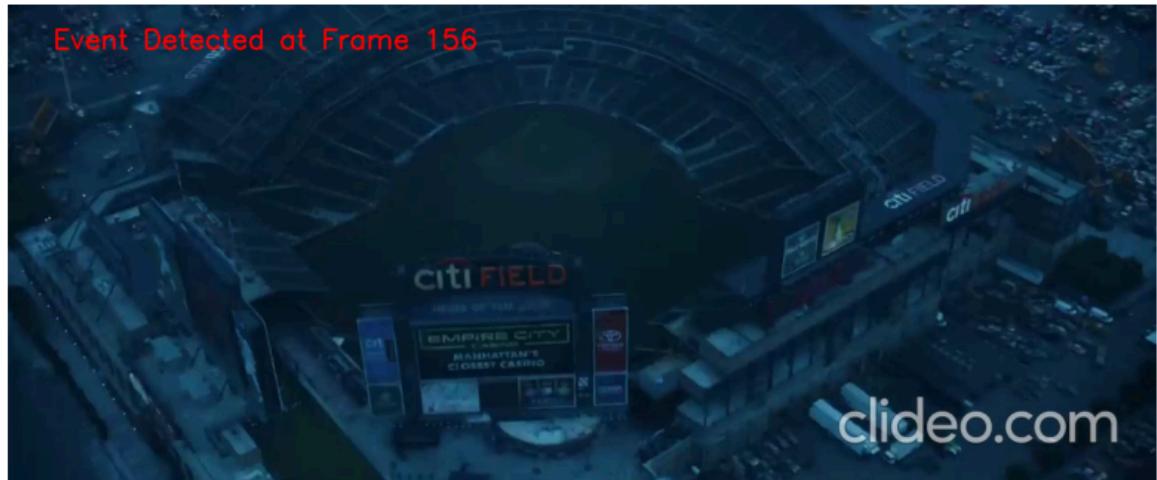
Event Detected at Frame 154



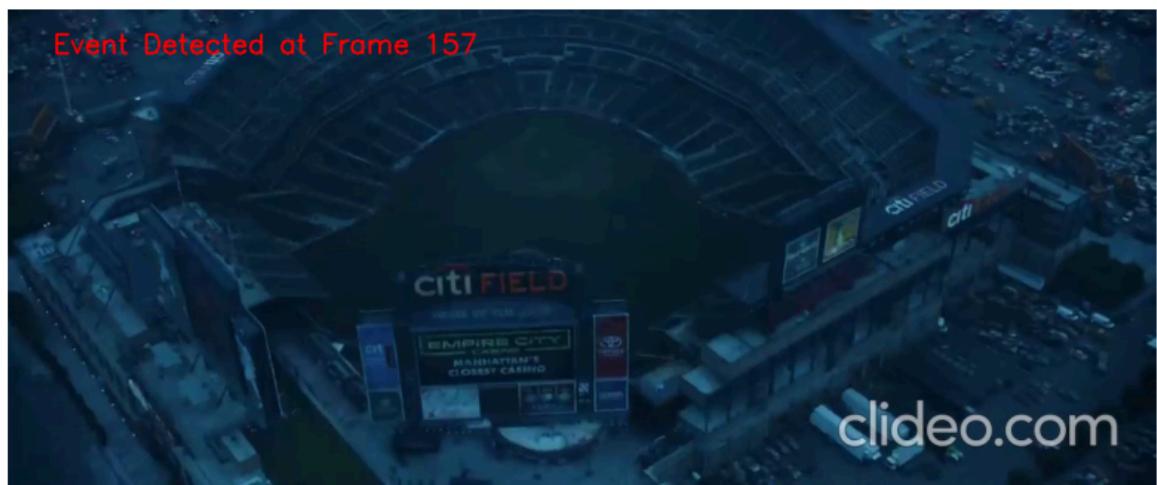
Event Detected at Frame 155



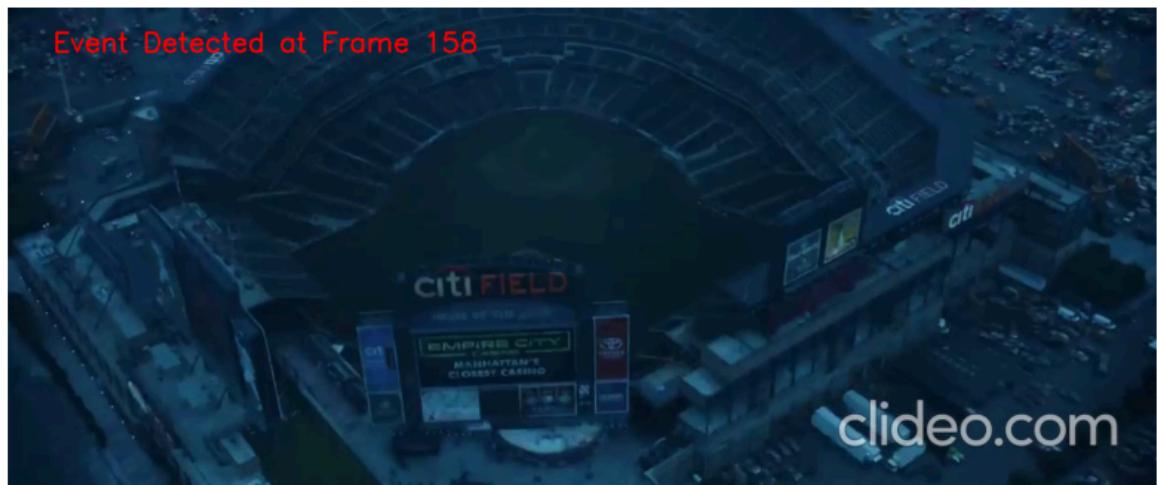
Event Detected at Frame 156



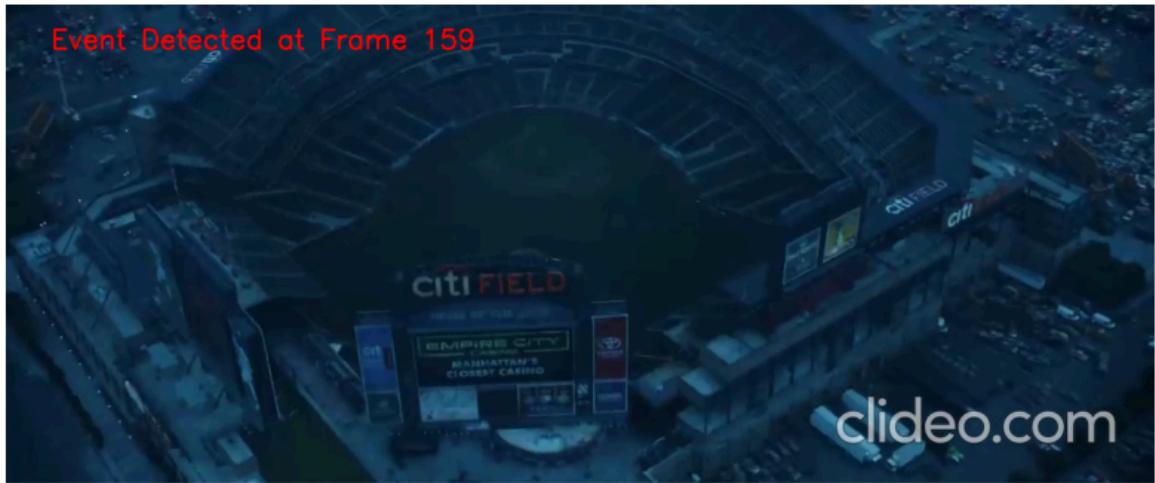
Event Detected at Frame 157



Event Detected at Frame 158



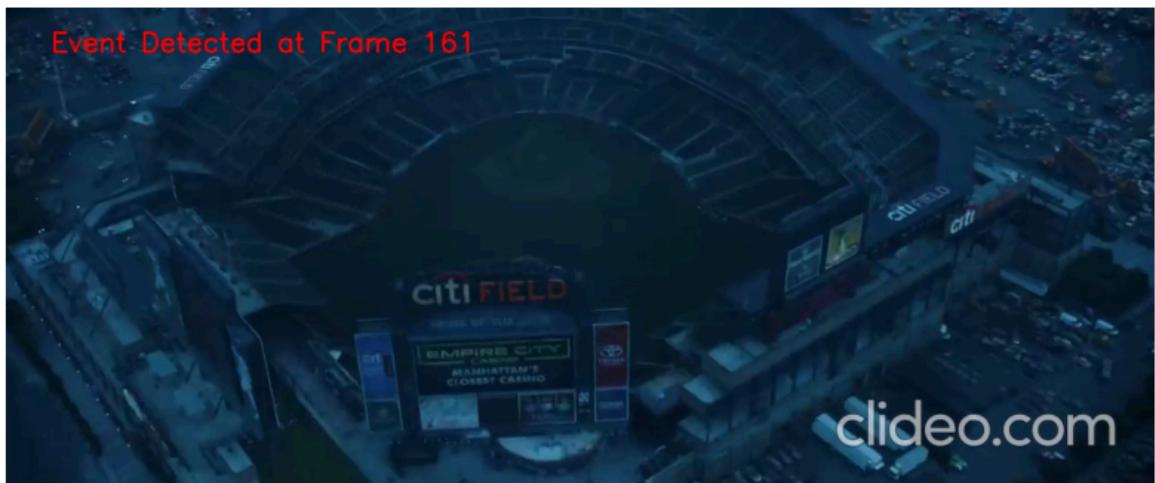
Event Detected at Frame 159



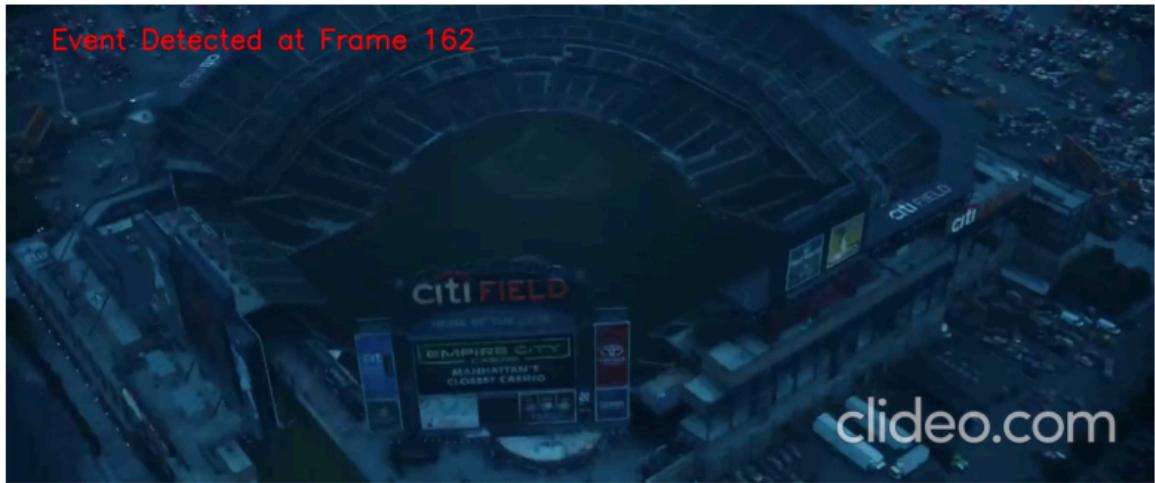
Event Detected at Frame 160



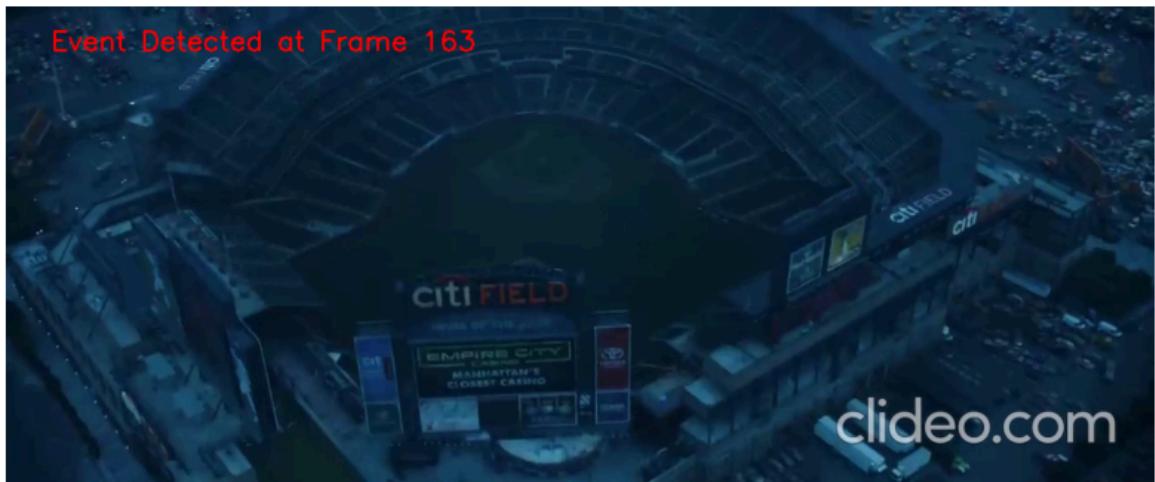
Event Detected at Frame 161



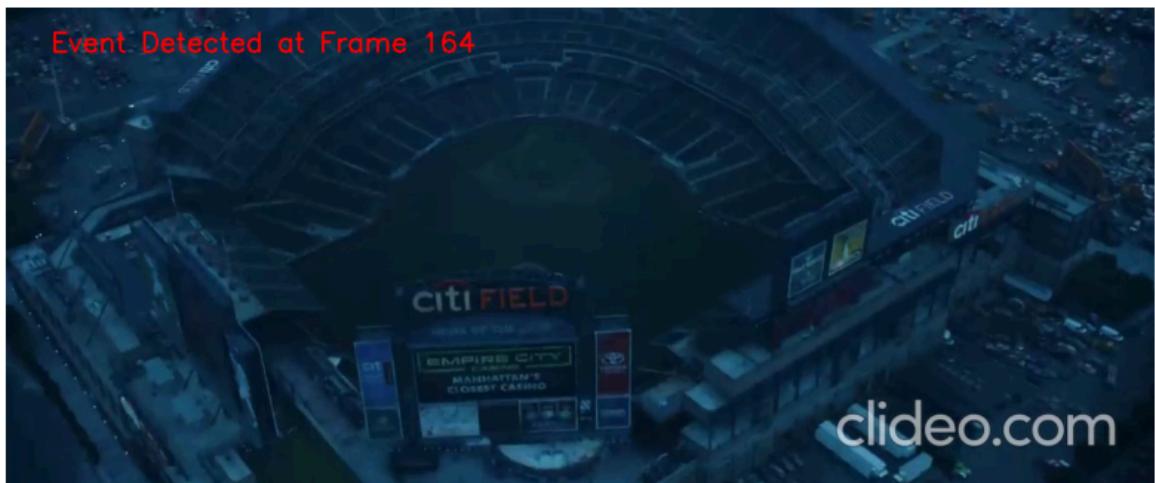
Event Detected at Frame 162



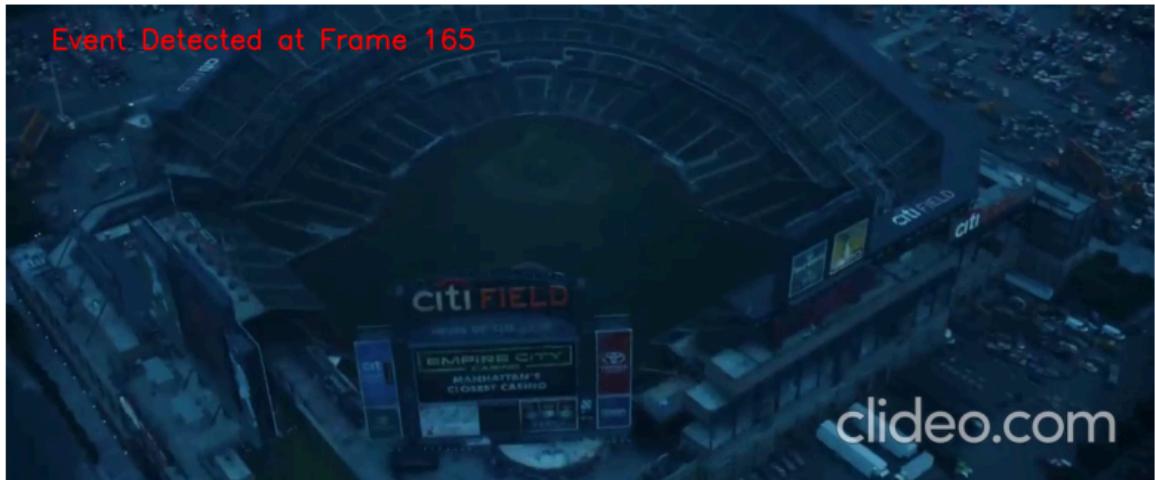
Event Detected at Frame 163



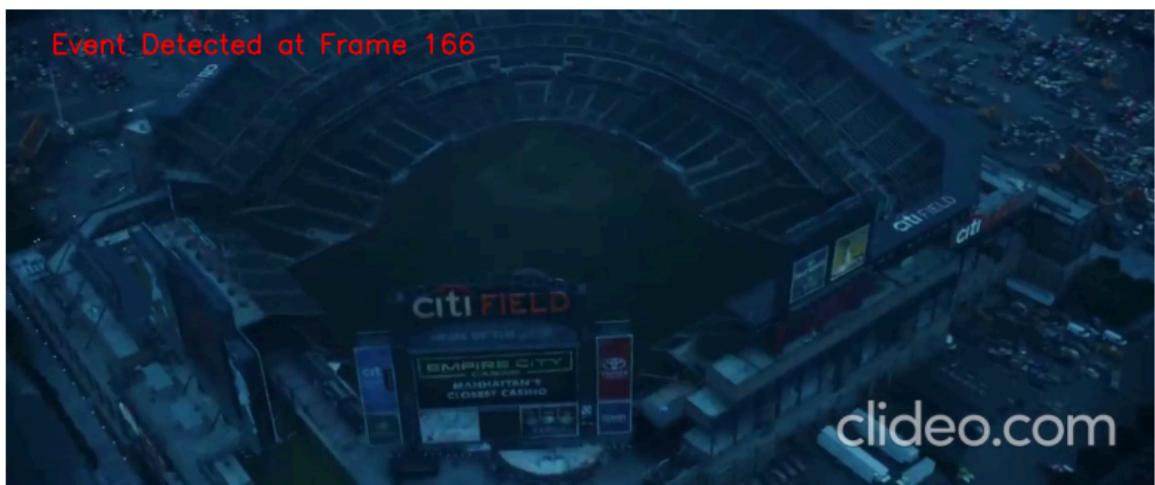
Event Detected at Frame 164



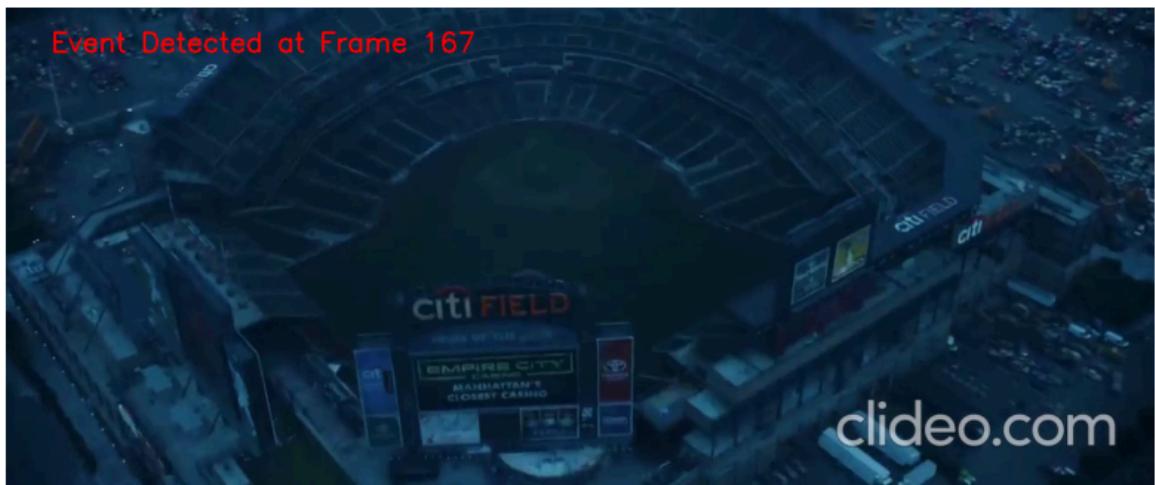
Event Detected at Frame 165



Event Detected at Frame 166



Event Detected at Frame 167



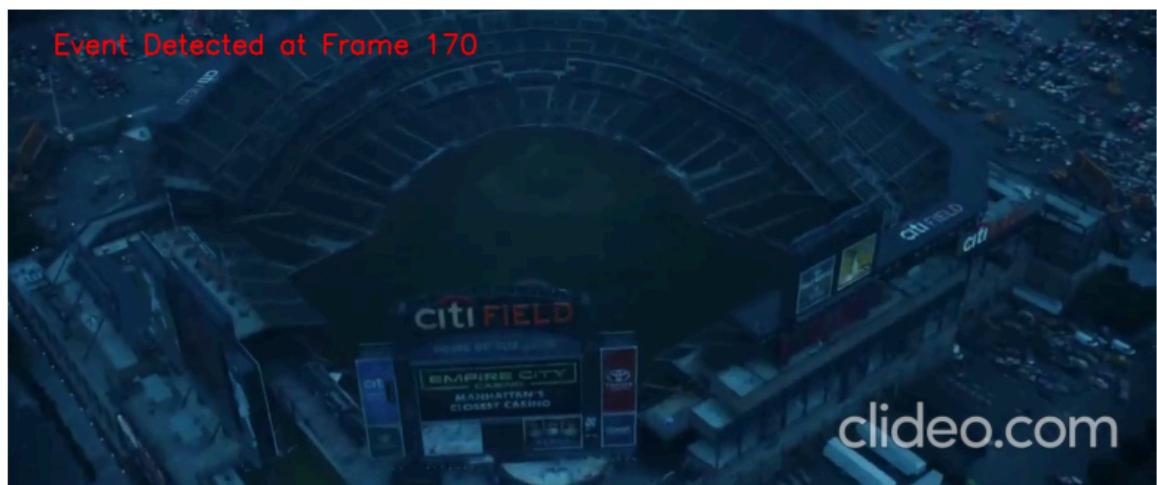
Event Detected at Frame 168



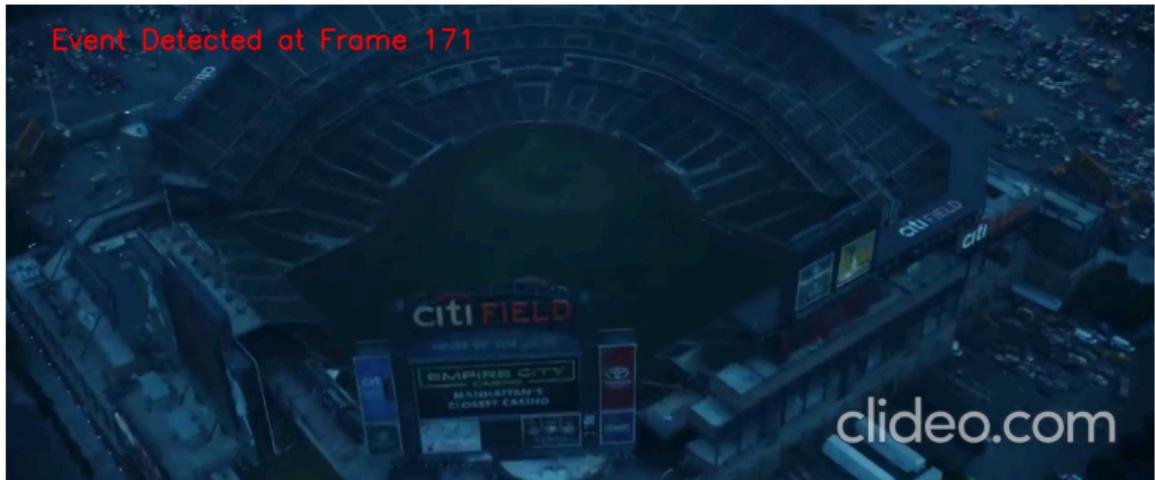
Event Detected at Frame 169



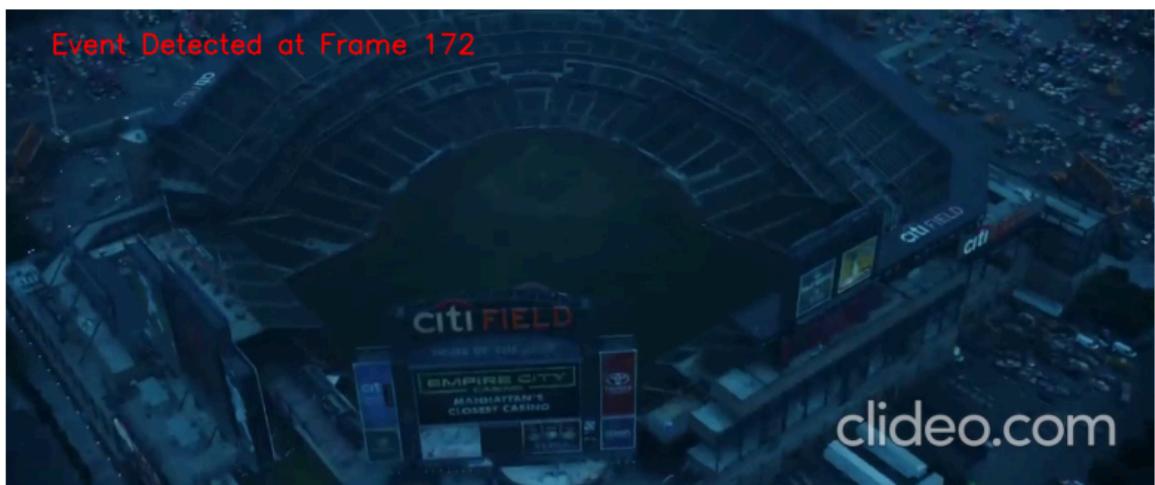
Event Detected at Frame 170



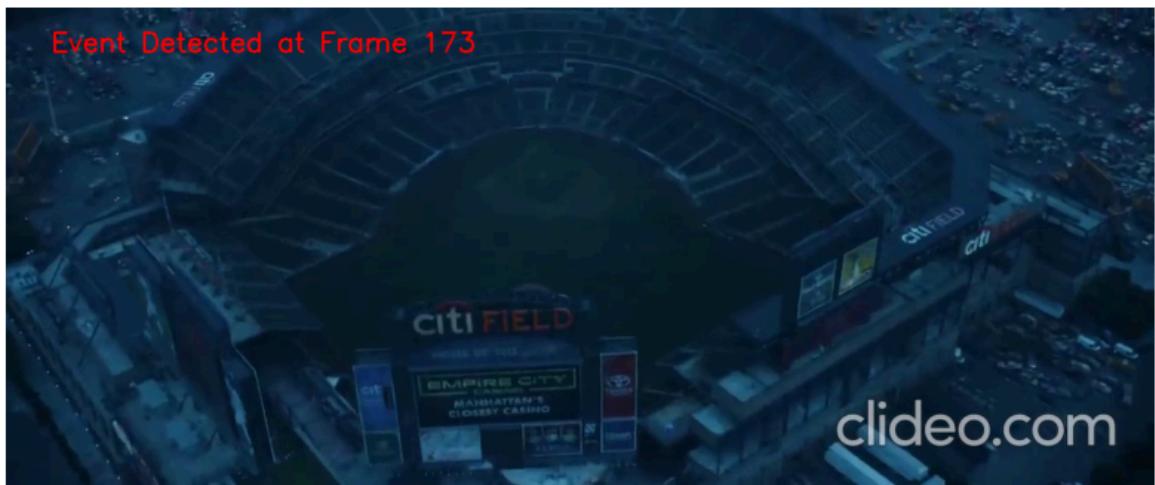
Event Detected at Frame 171



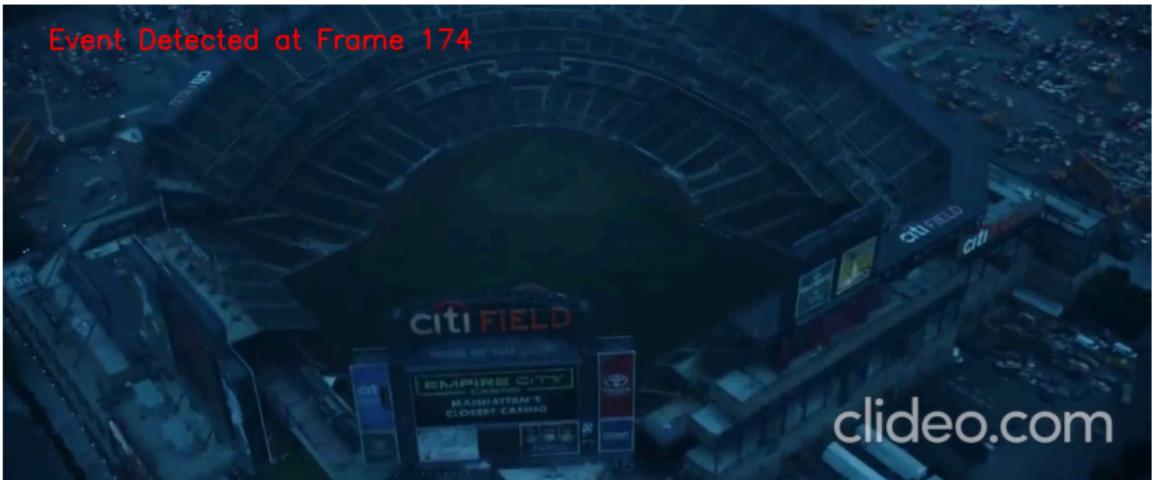
Event Detected at Frame 172



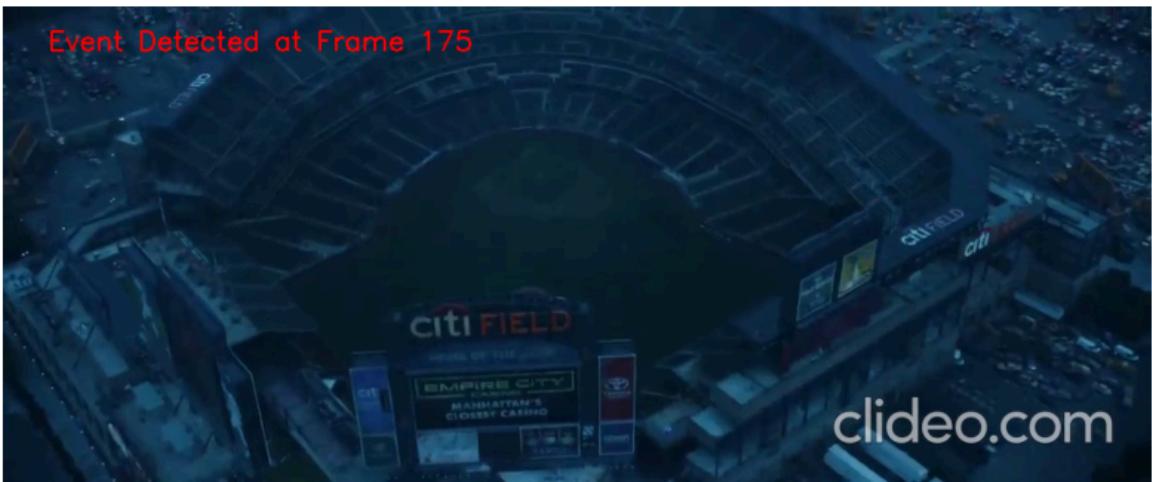
Event Detected at Frame 173



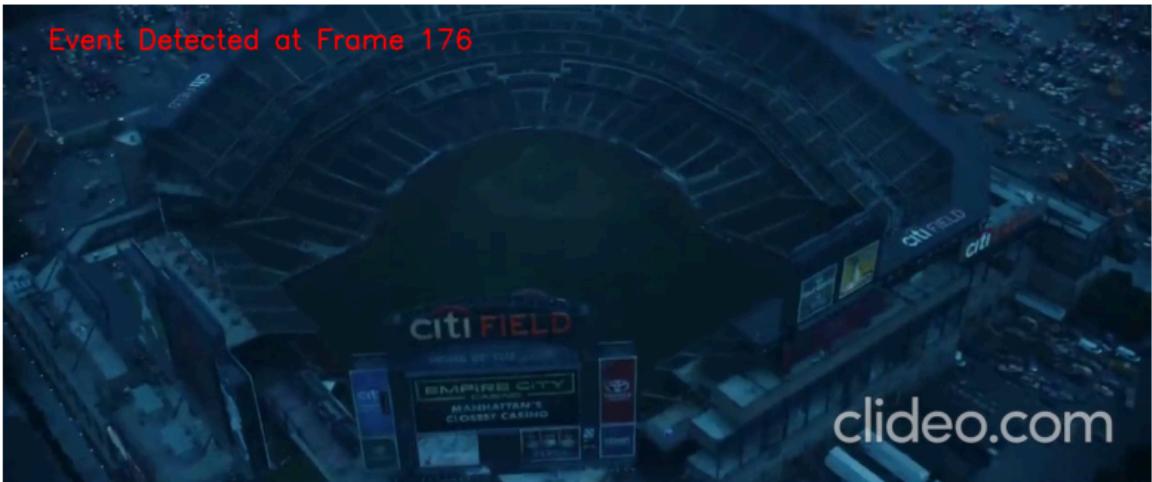
Event Detected at Frame 174



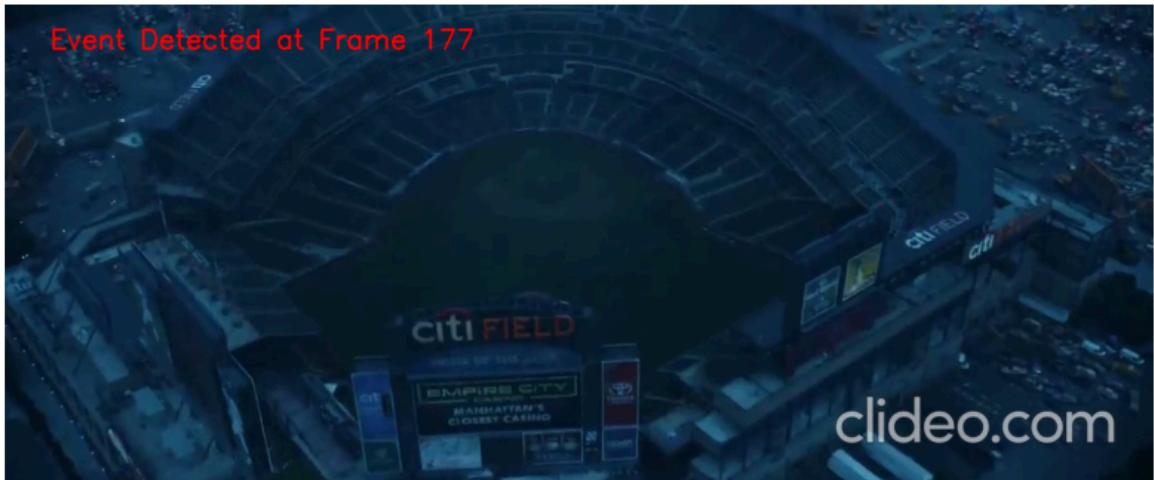
Event Detected at Frame 175



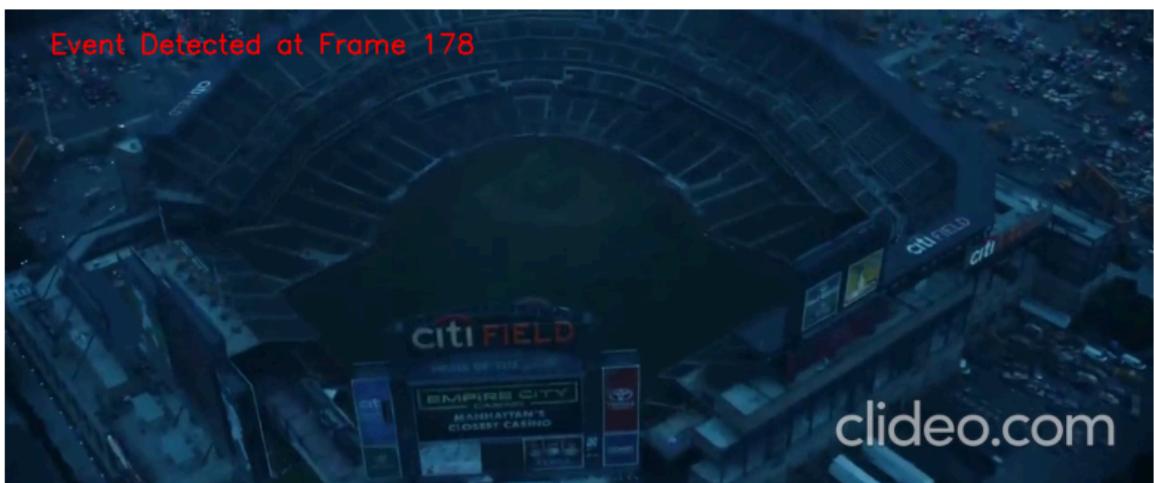
Event Detected at Frame 176



Event Detected at Frame 177



Event Detected at Frame 178



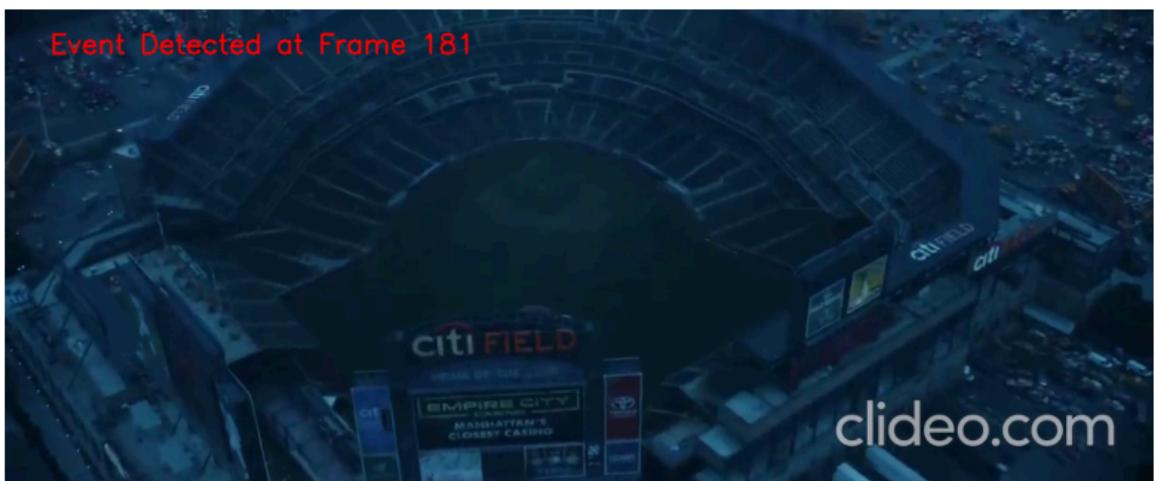
Event Detected at Frame 179



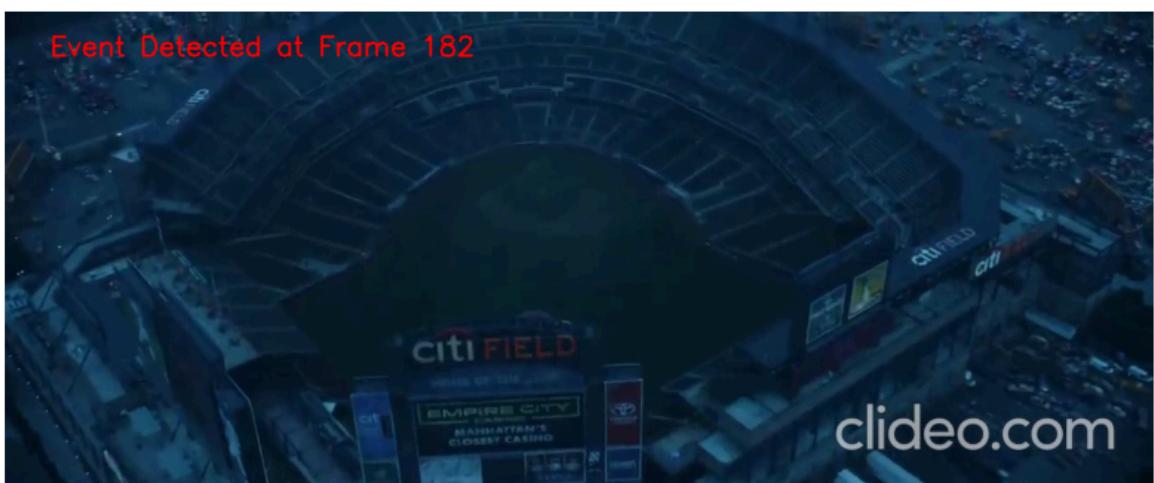
Event Detected at Frame 180



Event Detected at Frame 181



Event Detected at Frame 182



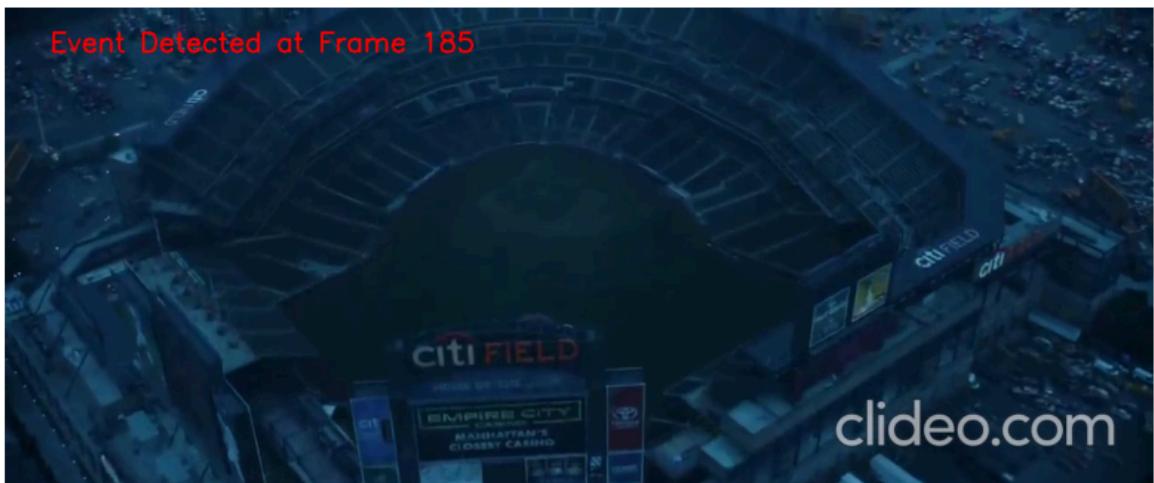
Event Detected at Frame 183



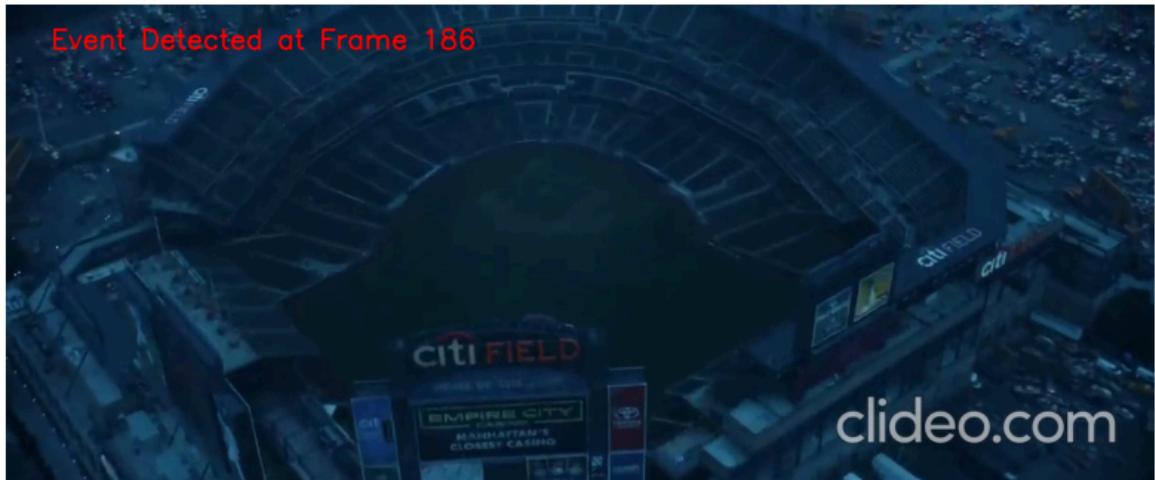
Event Detected at Frame 184



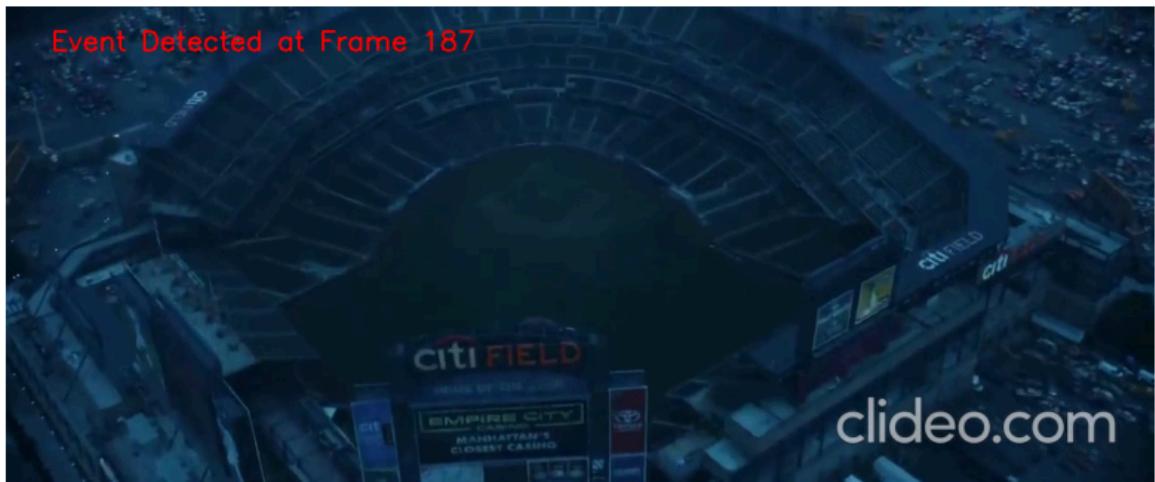
Event Detected at Frame 185



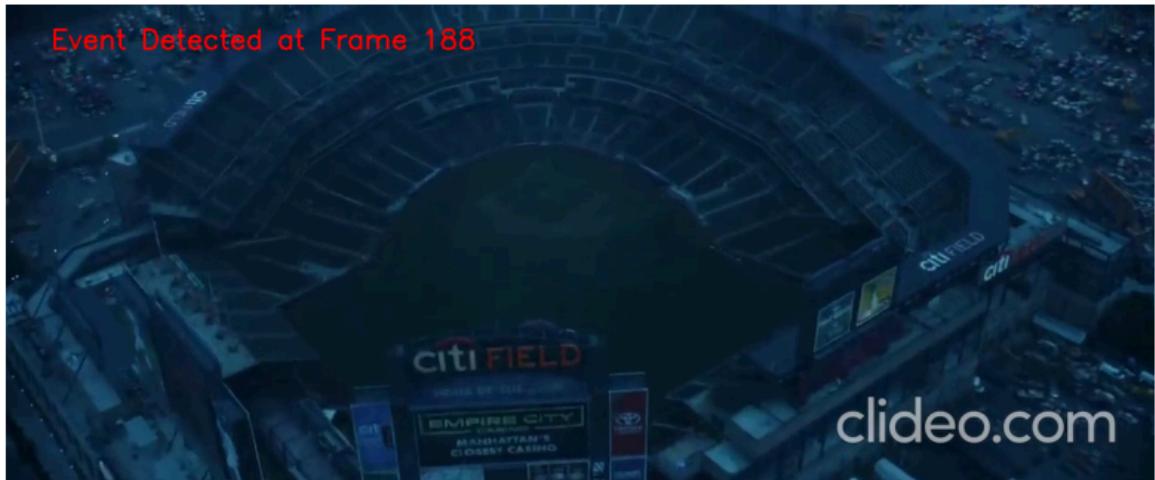
Event Detected at Frame 186



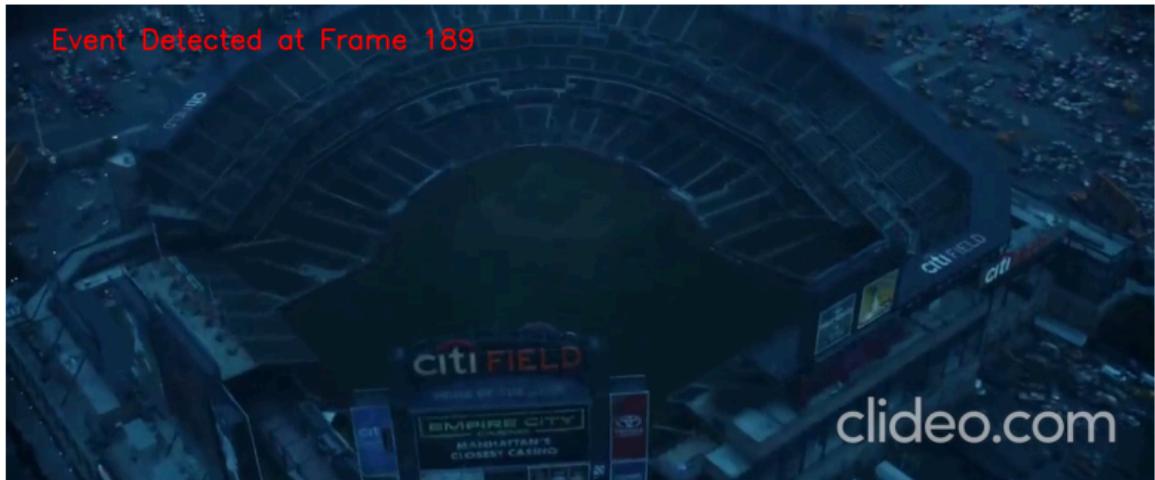
Event Detected at Frame 187



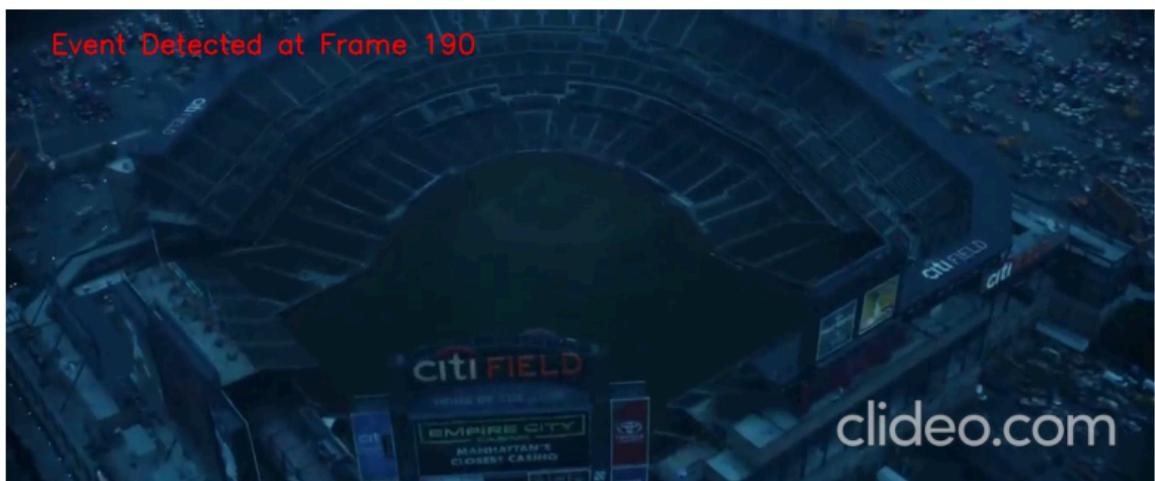
Event Detected at Frame 188



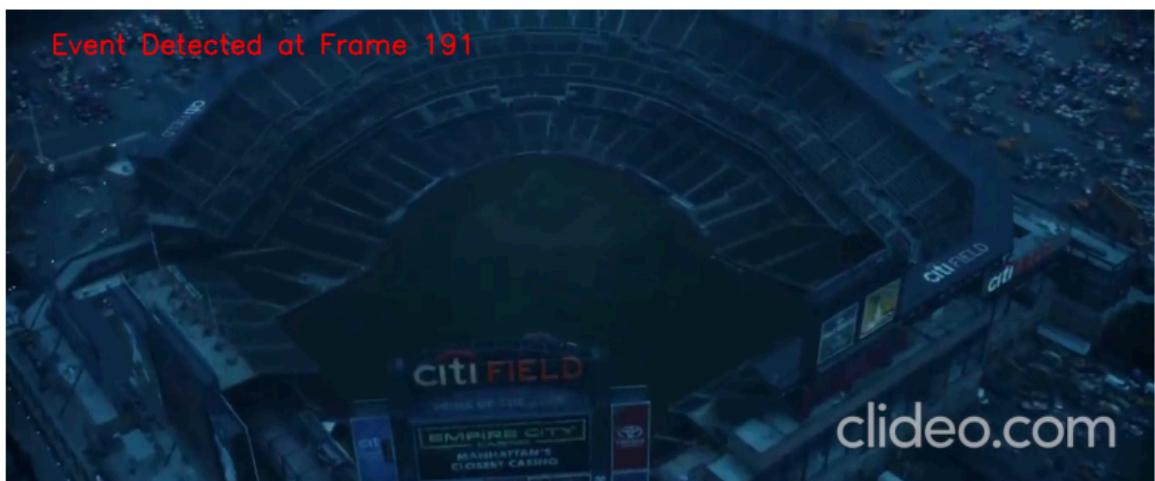
Event Detected at Frame 189



Event Detected at Frame 190



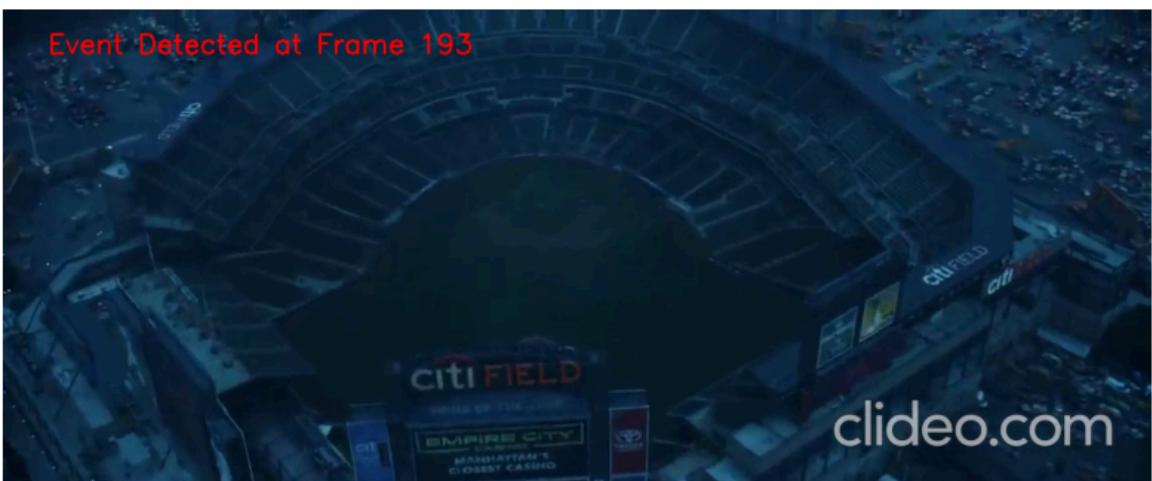
Event Detected at Frame 191



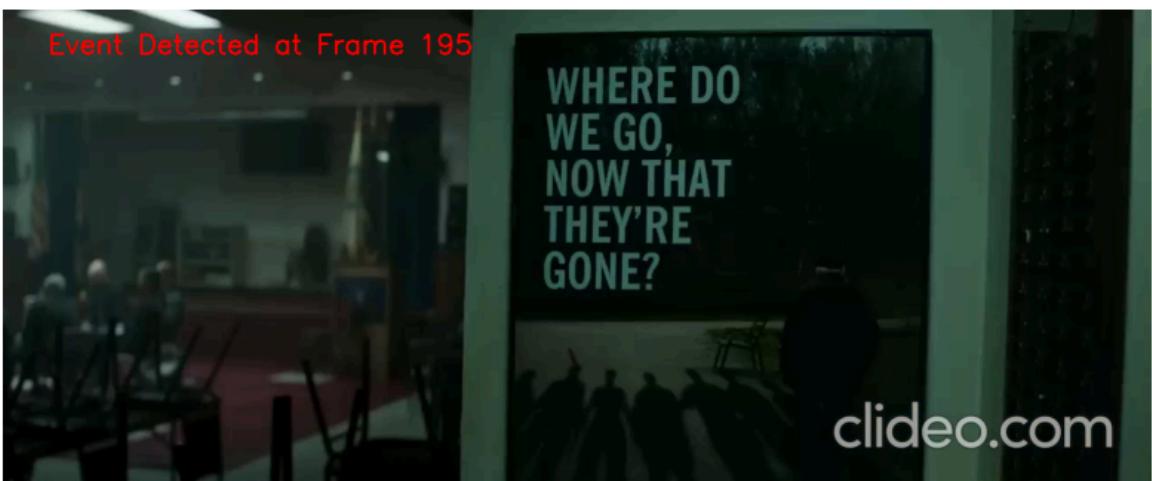
Event Detected at Frame 192



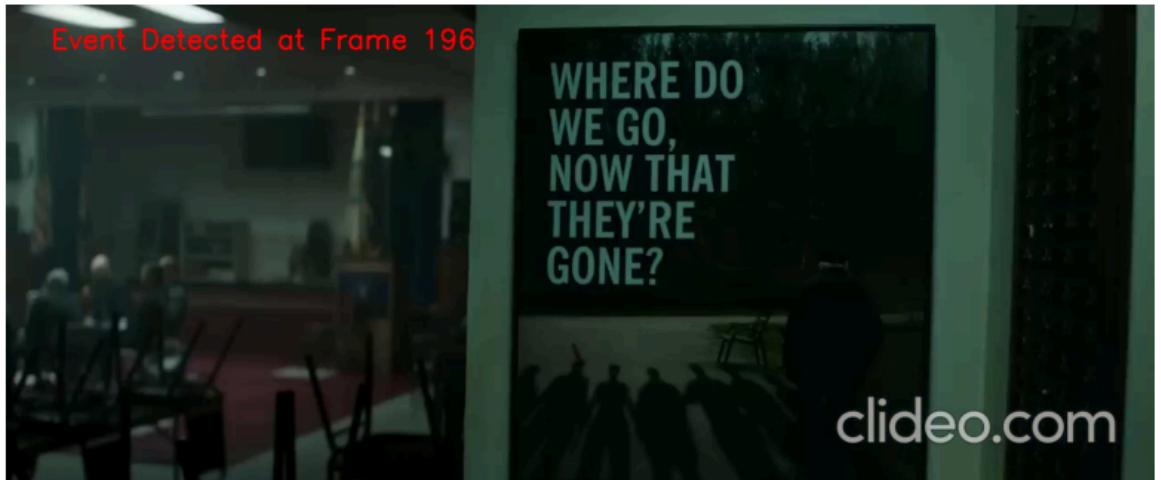
Event Detected at Frame 193



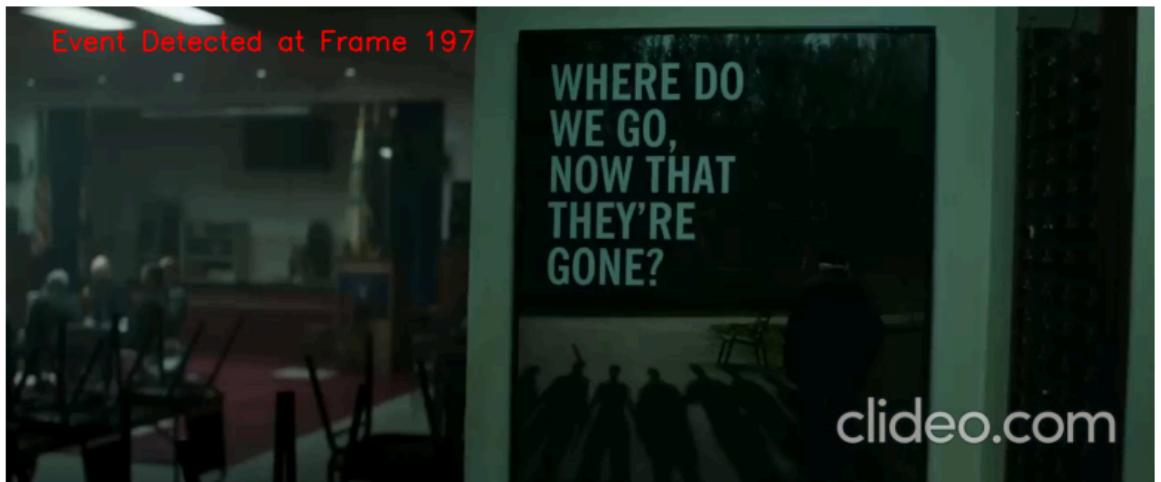
Event Detected at Frame 195



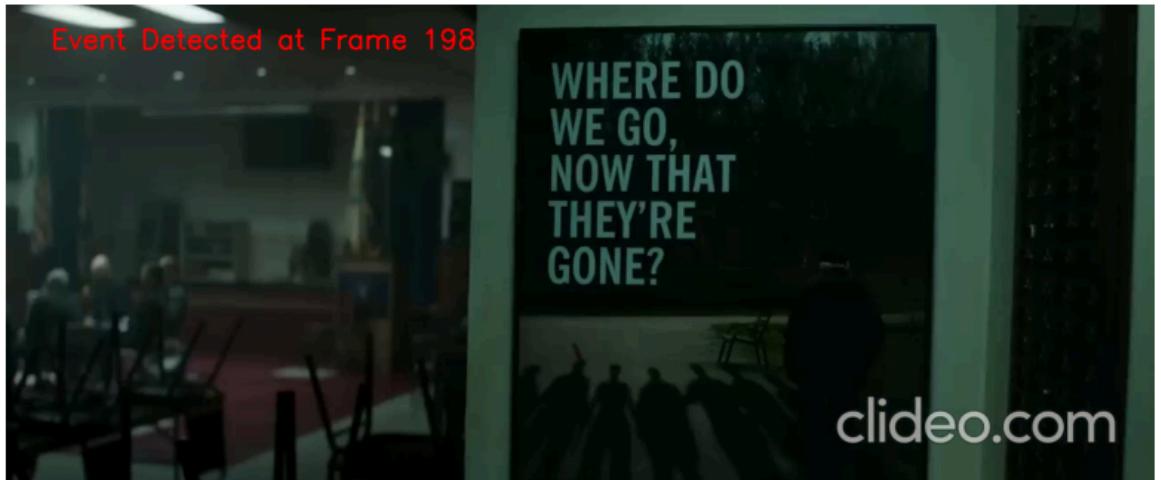
Event Detected at Frame 196



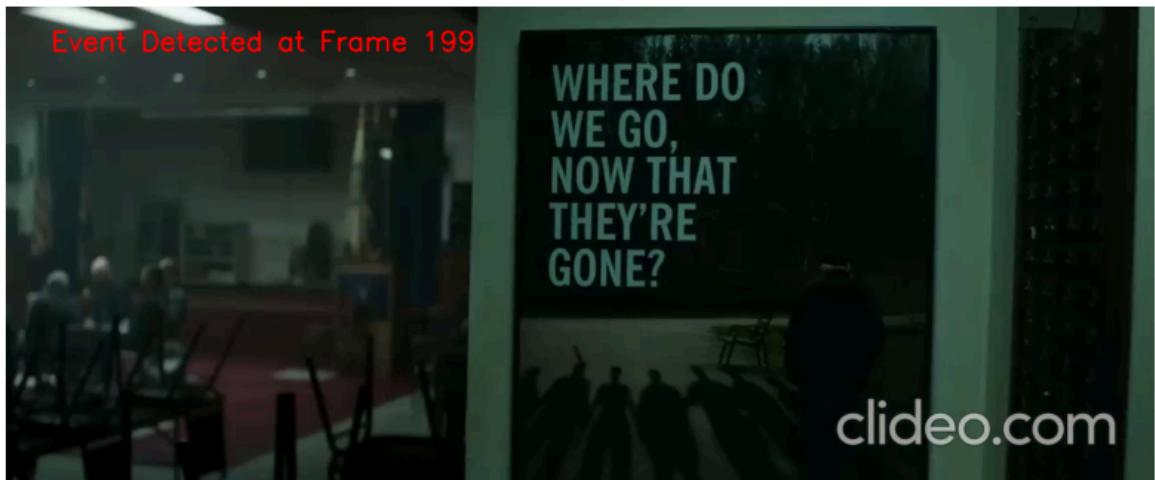
Event Detected at Frame 197



Event Detected at Frame 198



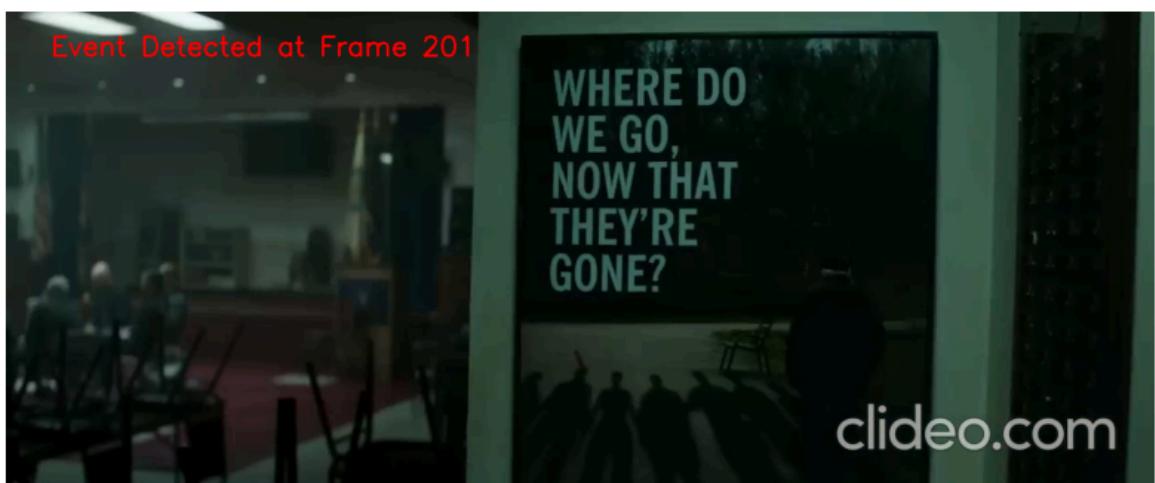
Event Detected at Frame 199



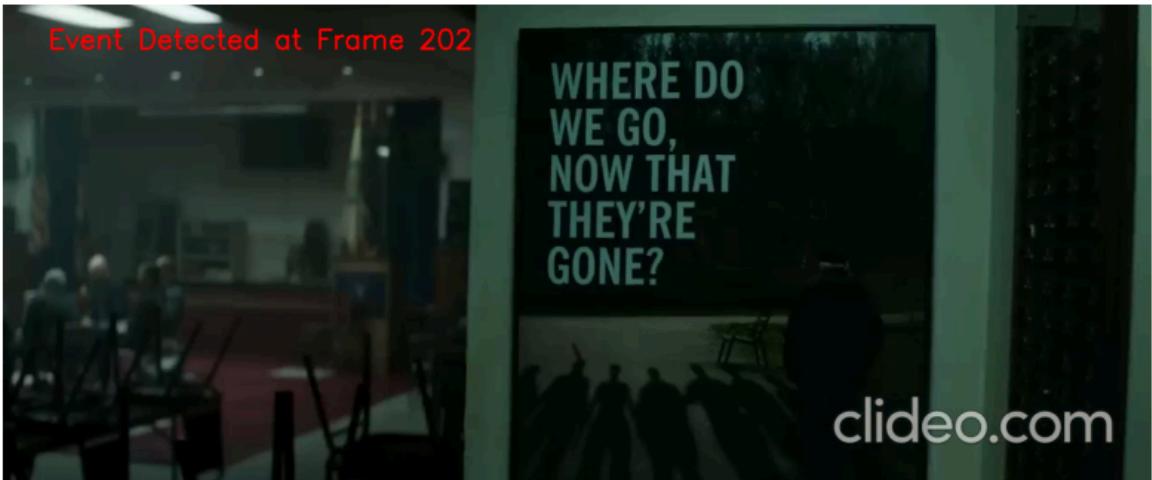
Event Detected at Frame 200



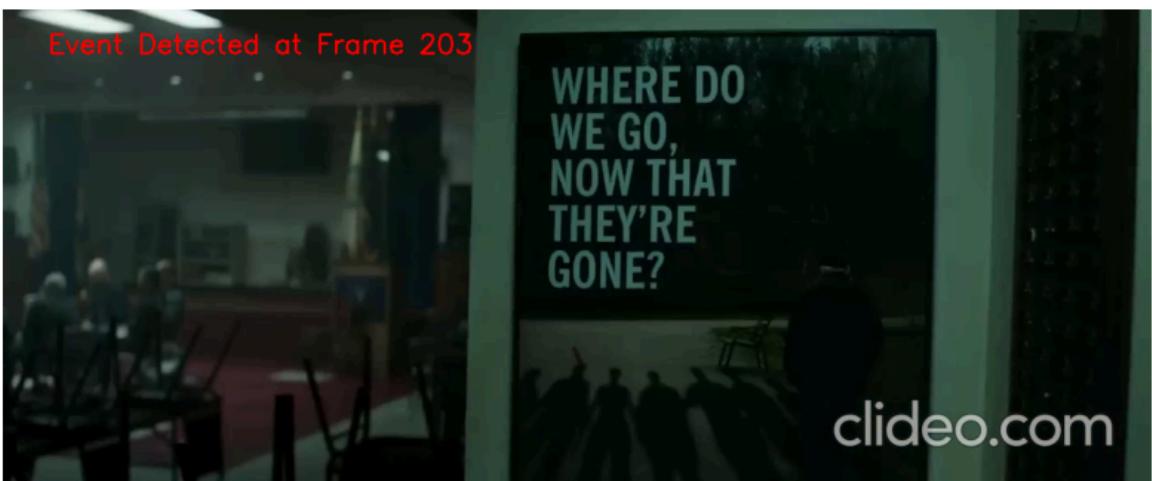
Event Detected at Frame 201



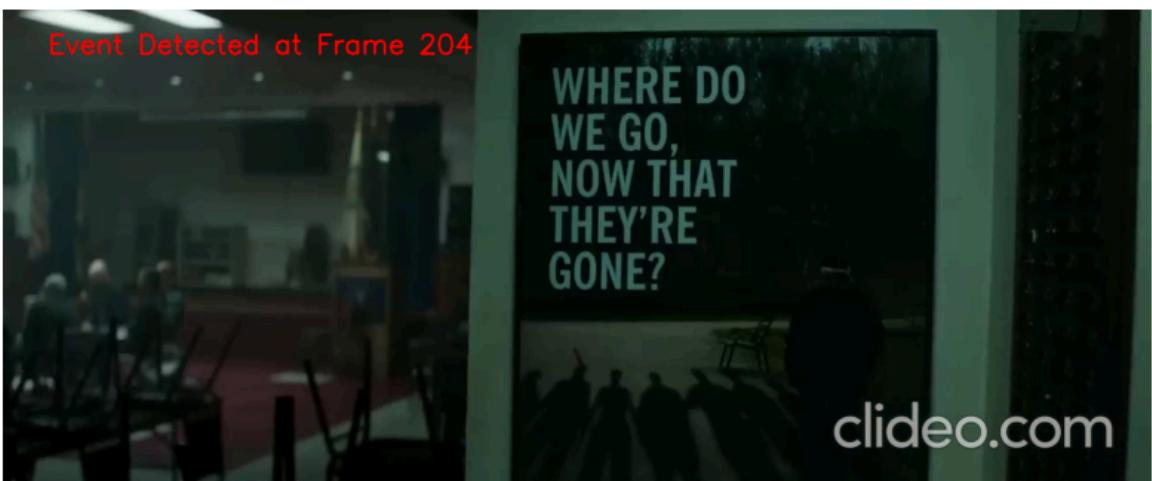
Event Detected at Frame 202



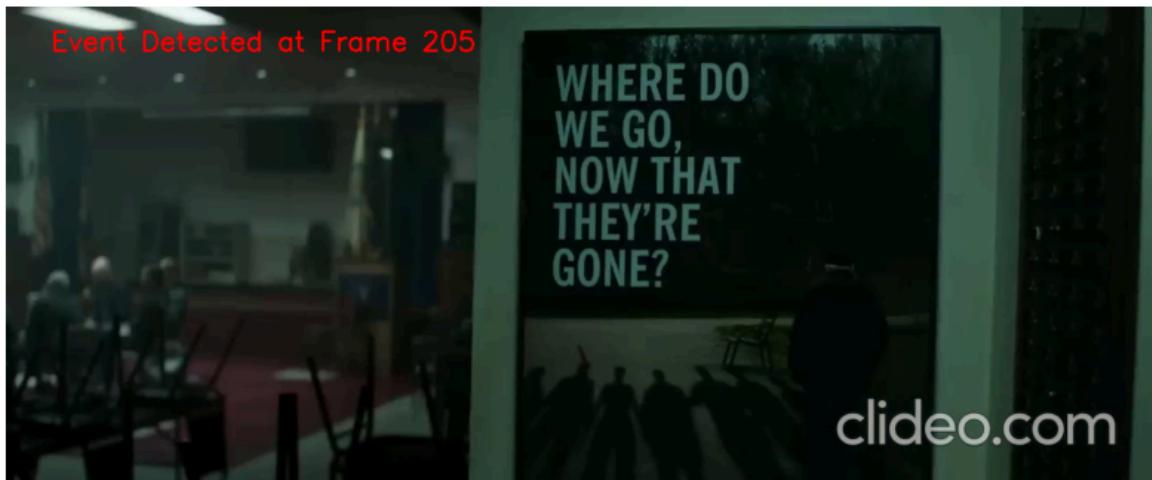
Event Detected at Frame 203



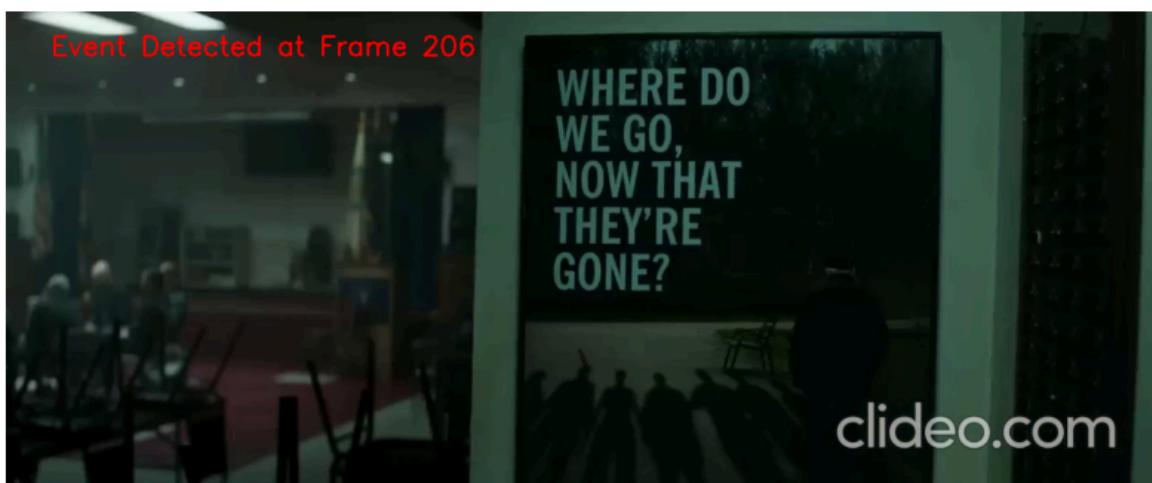
Event Detected at Frame 204



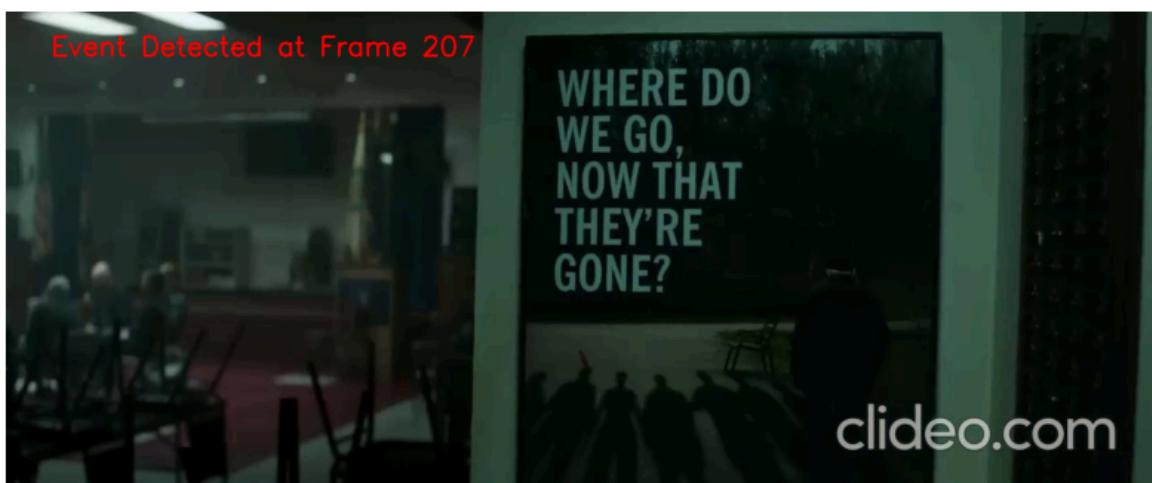
Event Detected at Frame 205



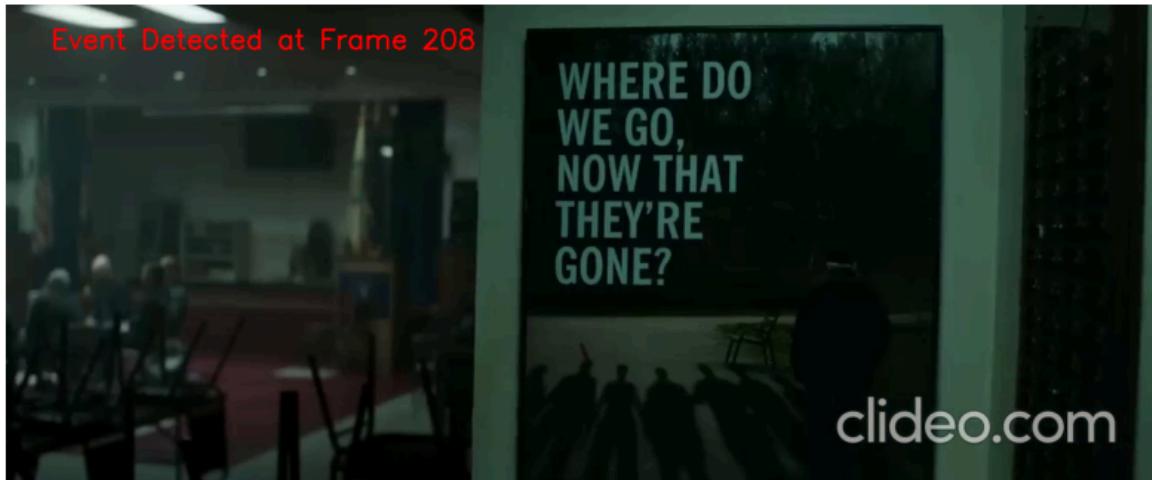
Event Detected at Frame 206



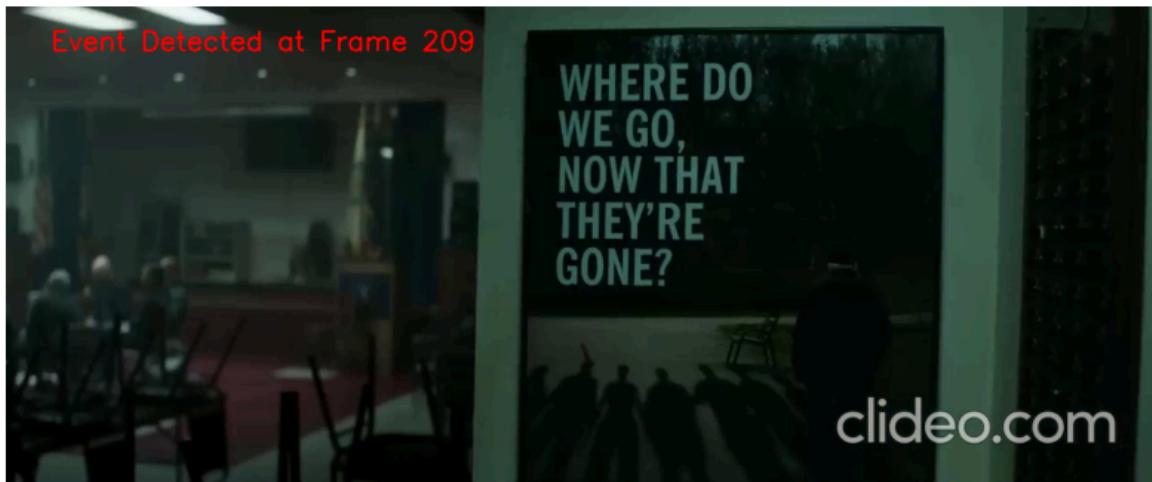
Event Detected at Frame 207



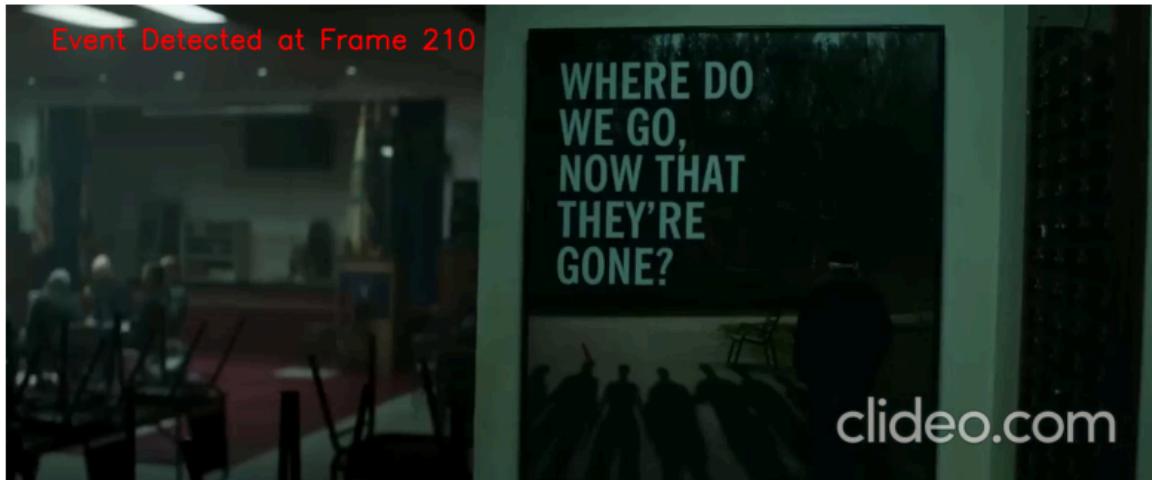
Event Detected at Frame 208



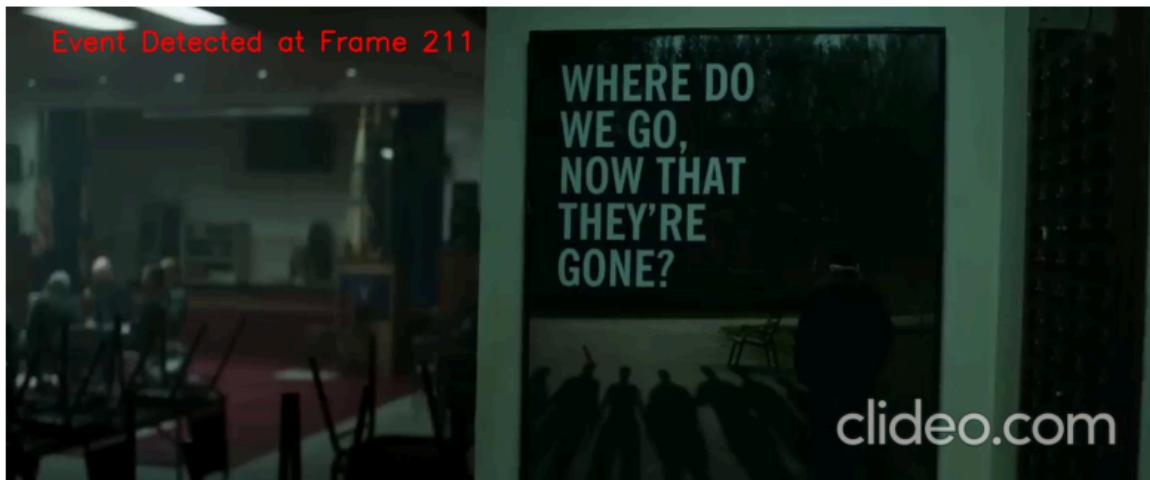
Event Detected at Frame 209



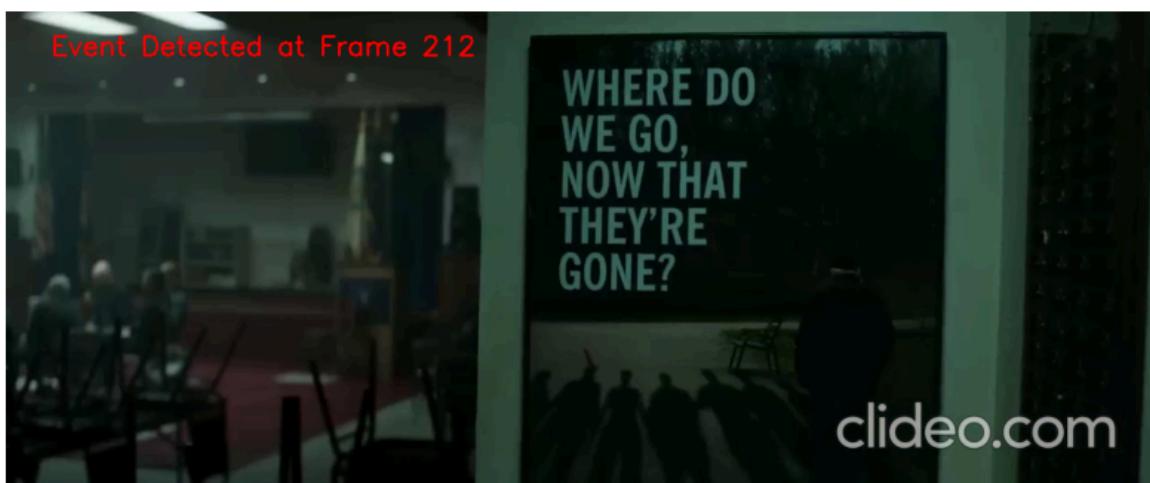
Event Detected at Frame 210



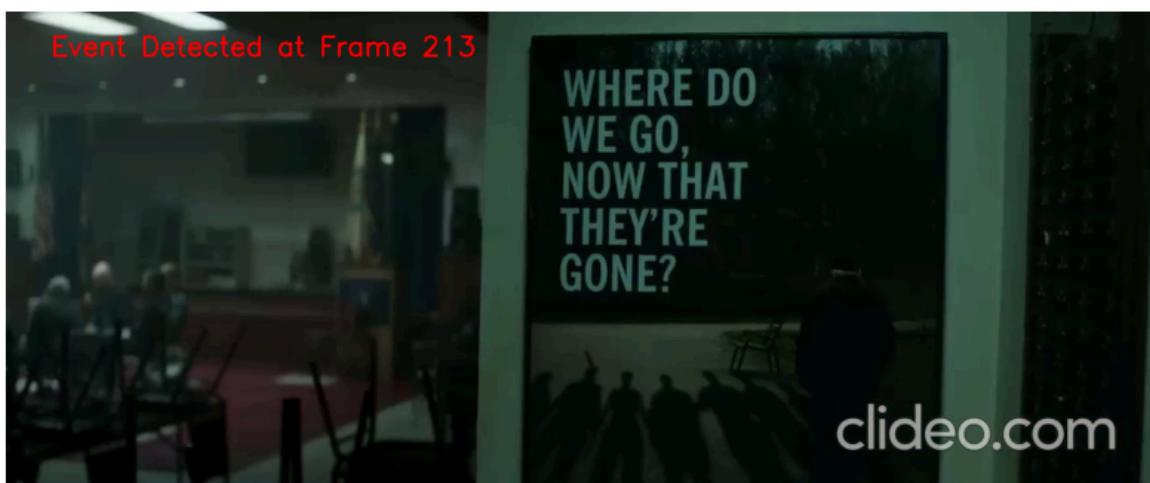
Event Detected at Frame 211



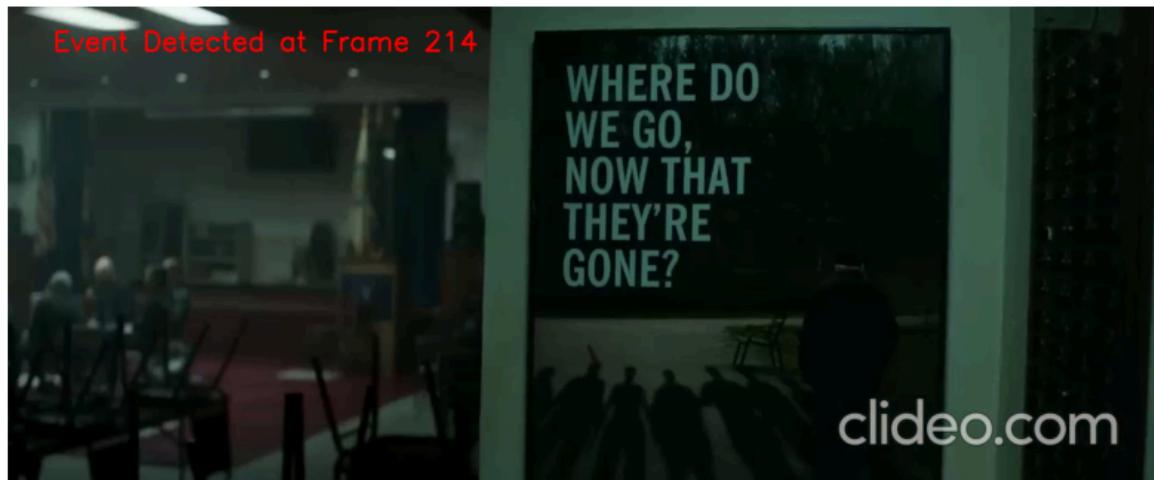
Event Detected at Frame 212



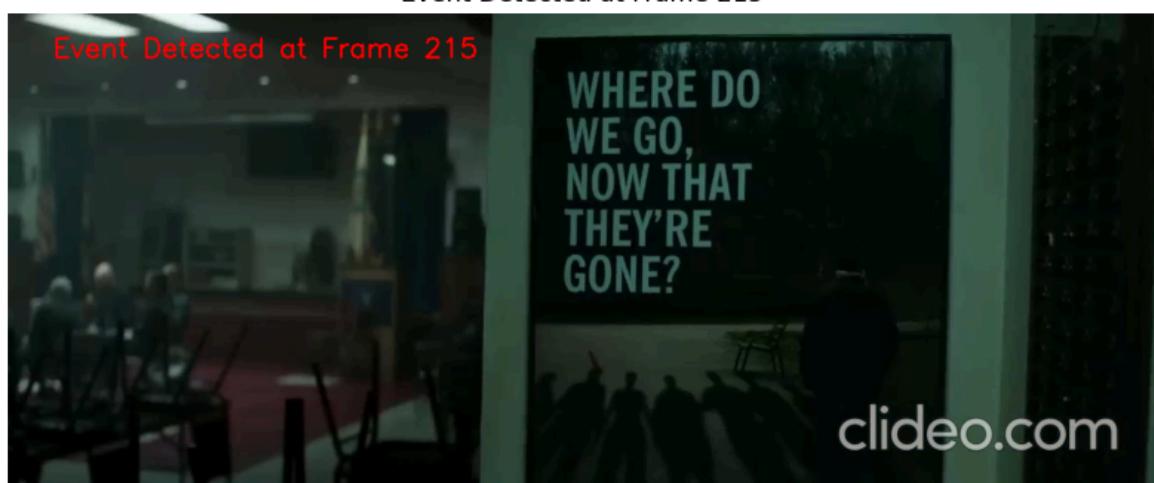
Event Detected at Frame 213



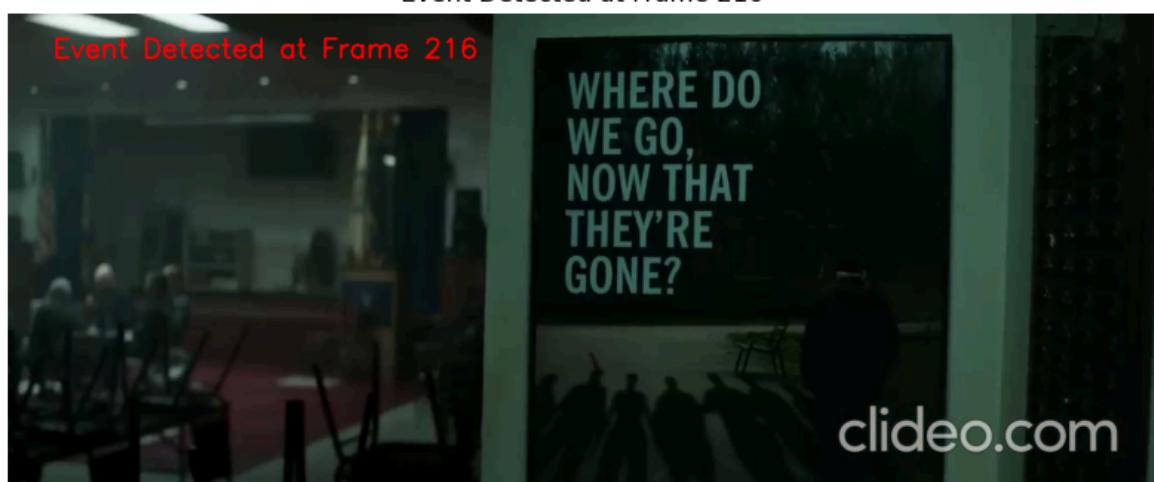
Event Detected at Frame 214



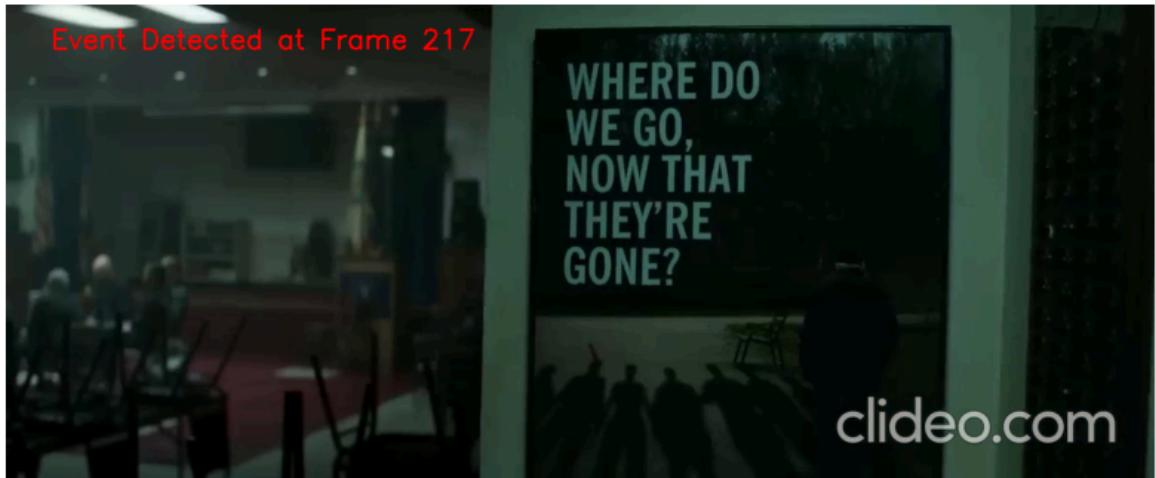
Event Detected at Frame 215



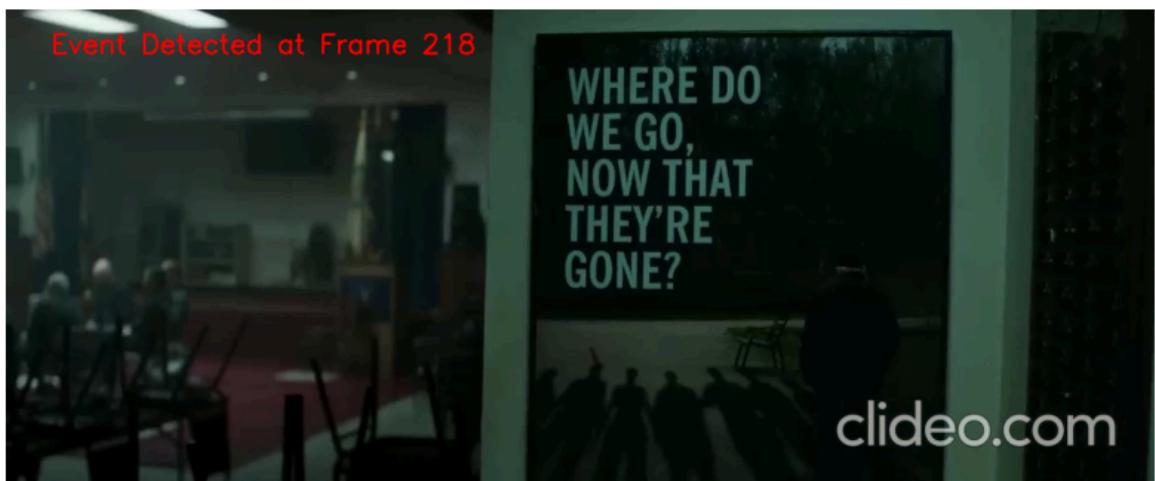
Event Detected at Frame 216



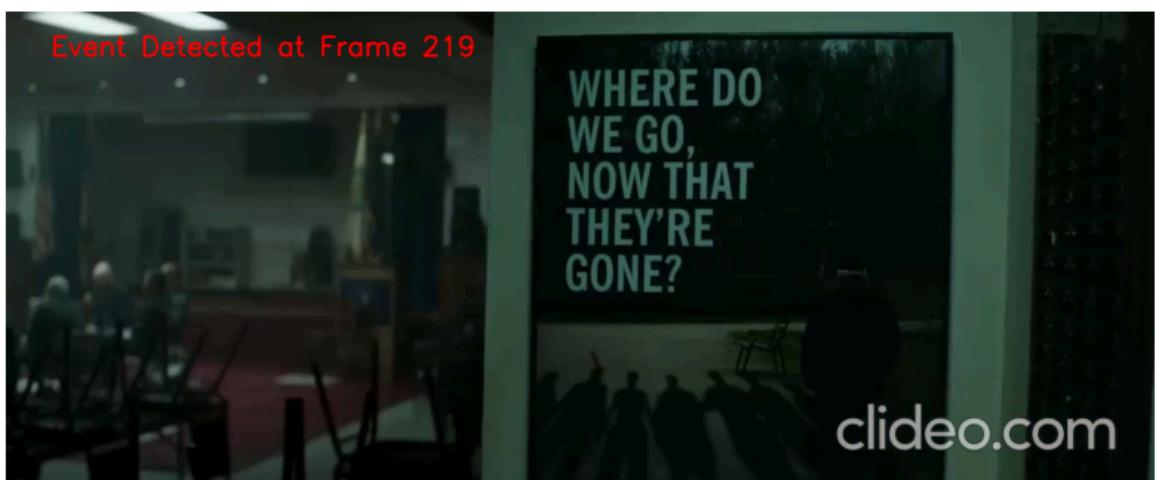
Event Detected at Frame 217



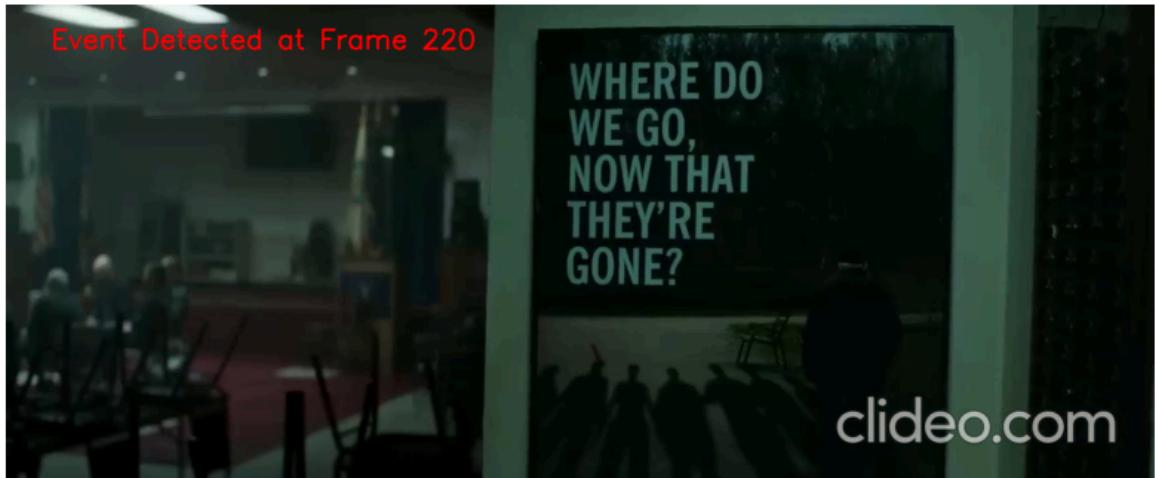
Event Detected at Frame 218



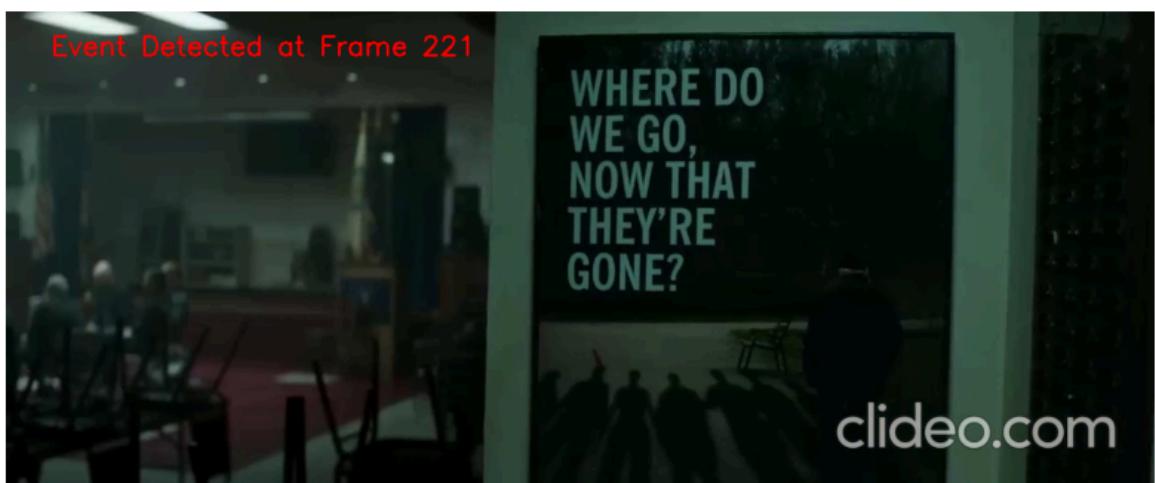
Event Detected at Frame 219



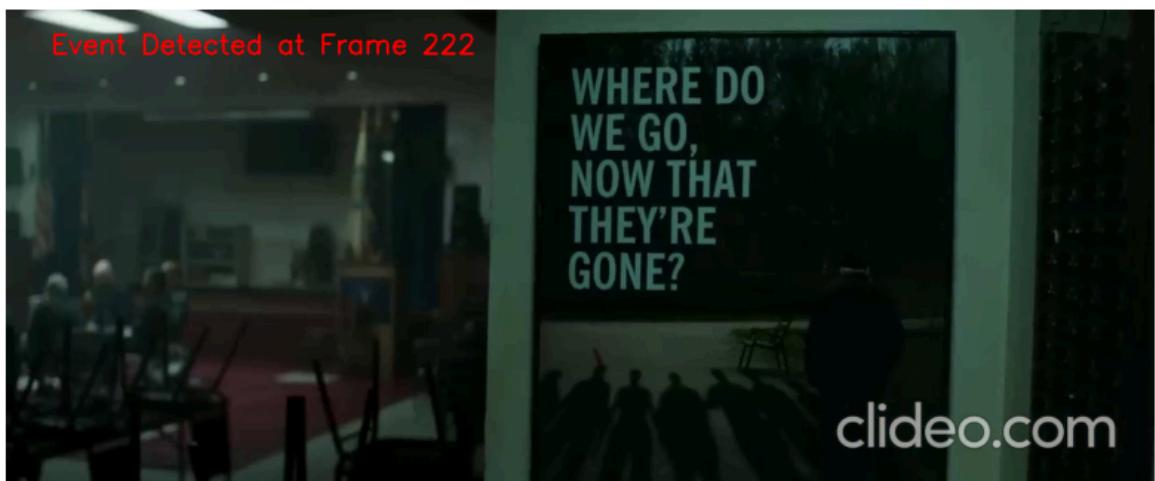
Event Detected at Frame 220



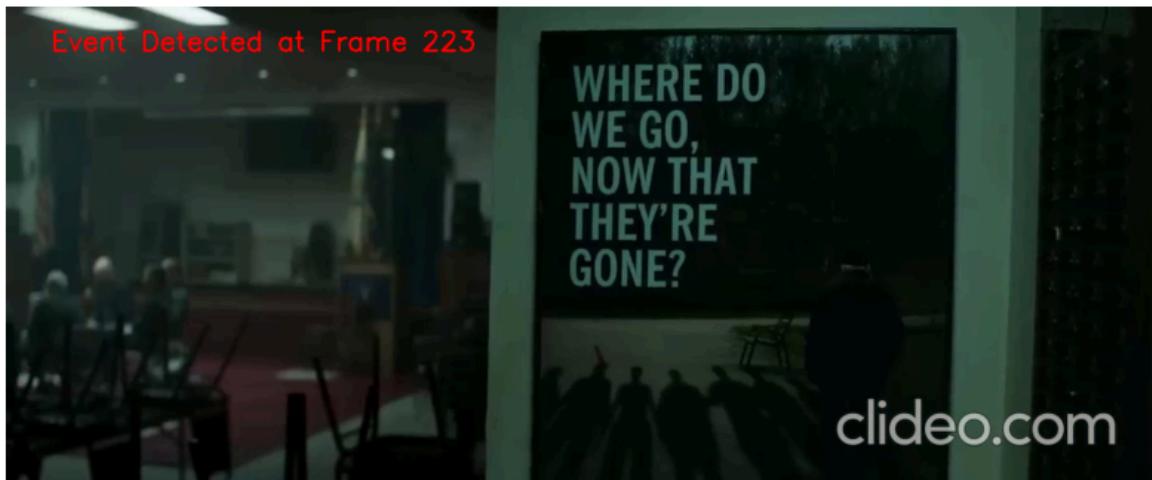
Event Detected at Frame 221



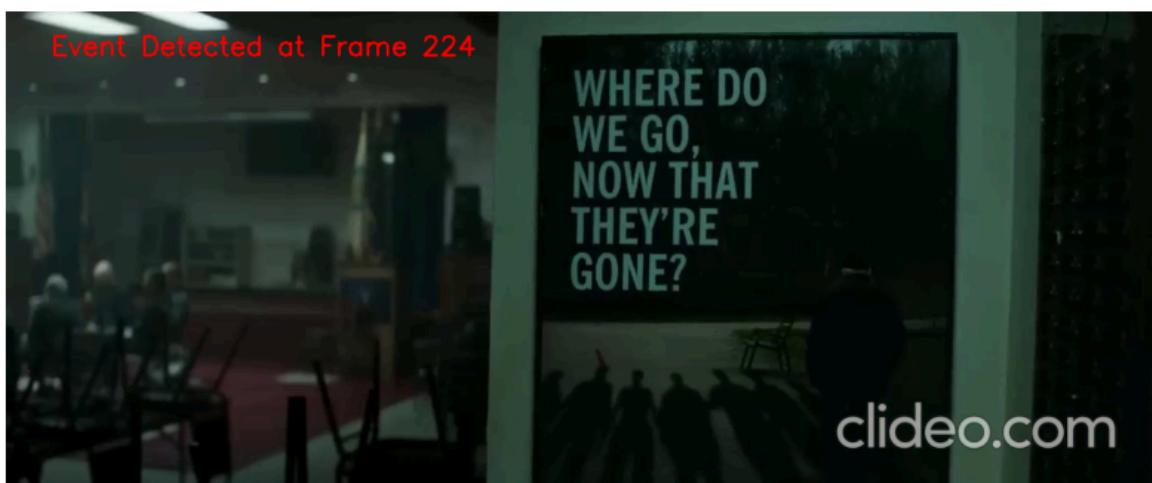
Event Detected at Frame 222



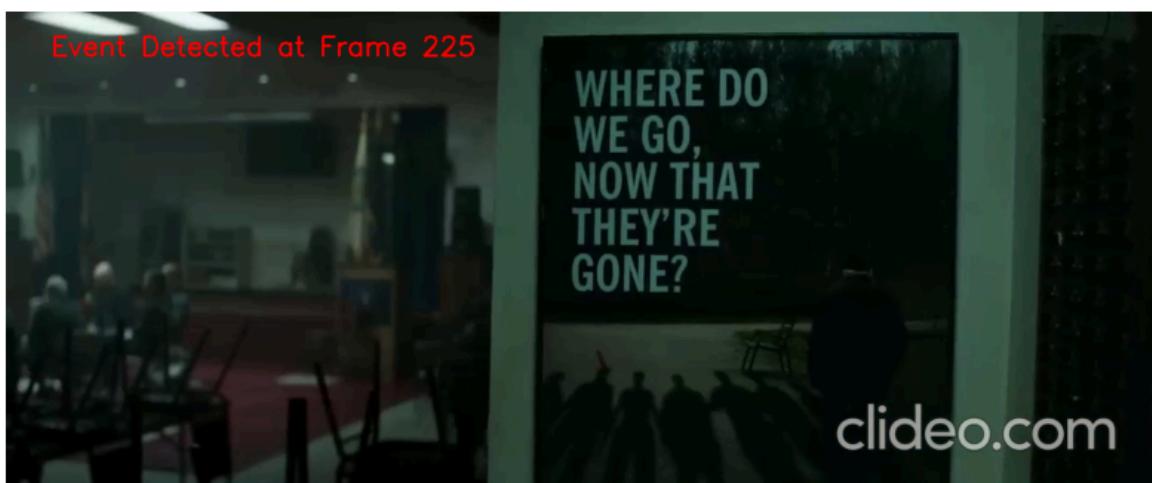
Event Detected at Frame 223



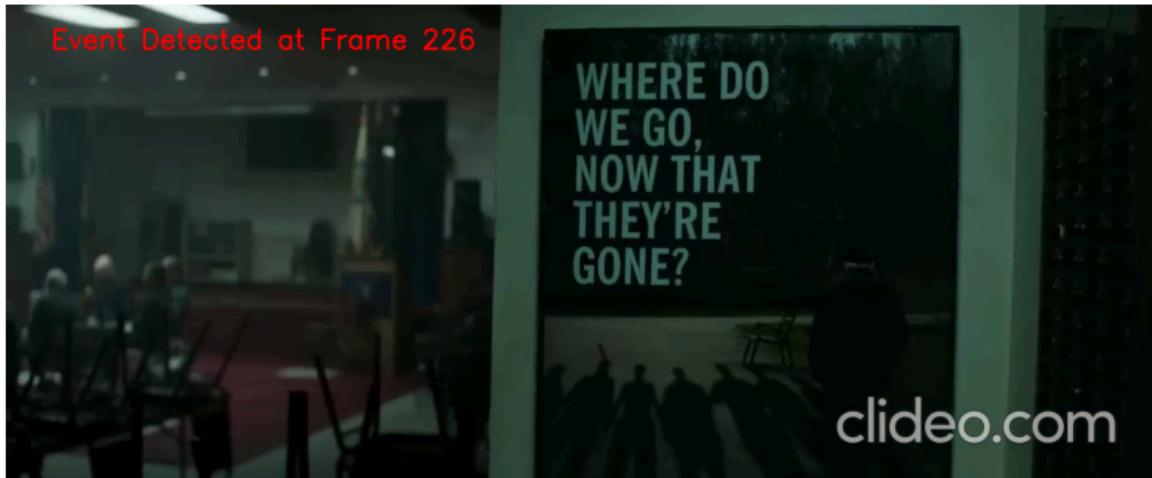
Event Detected at Frame 224



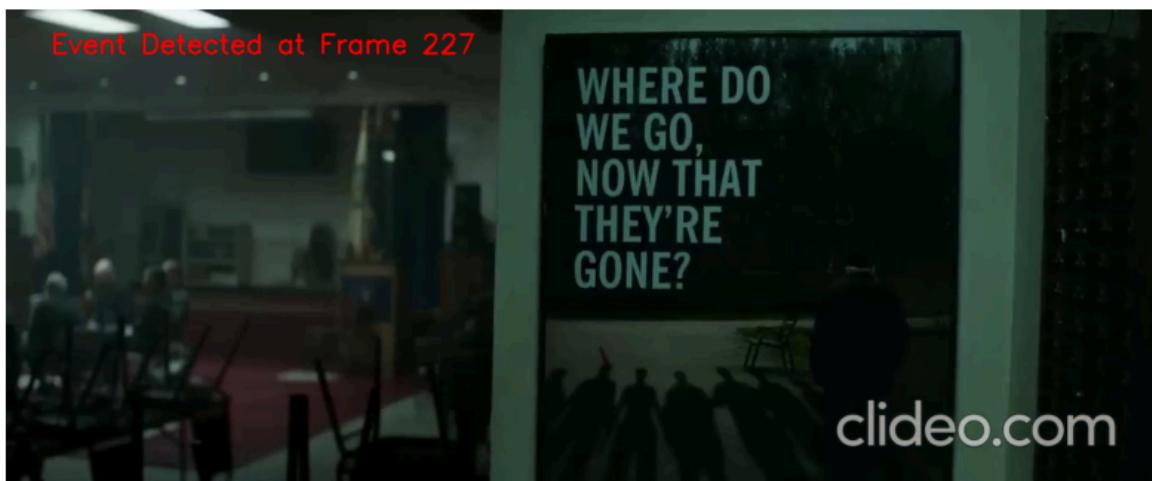
Event Detected at Frame 225



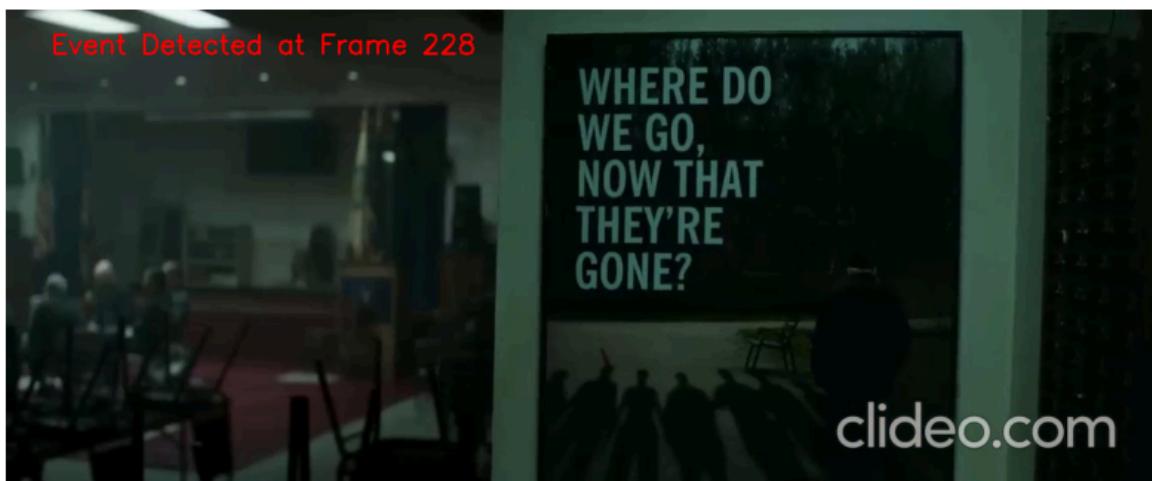
Event Detected at Frame 226



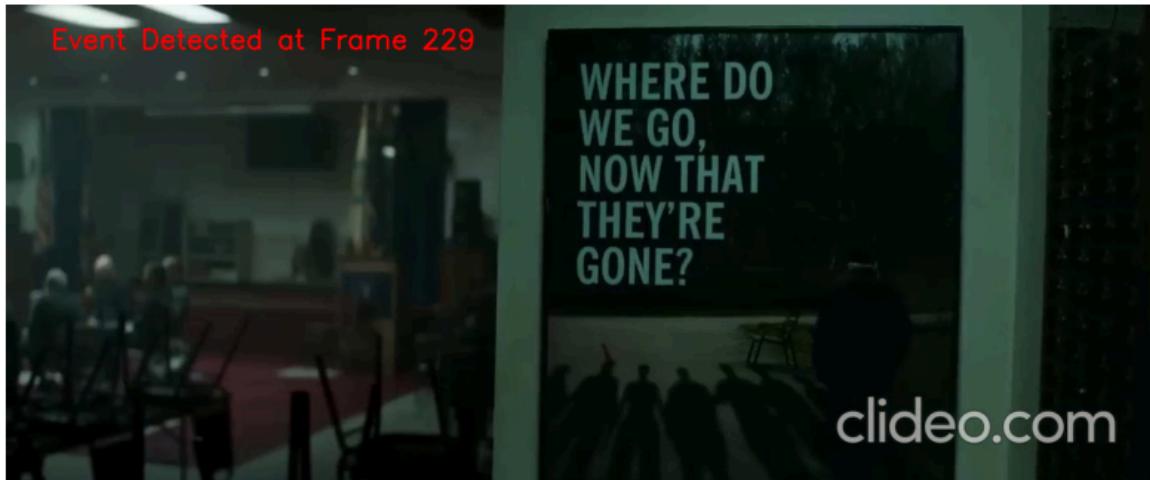
Event Detected at Frame 227



Event Detected at Frame 228



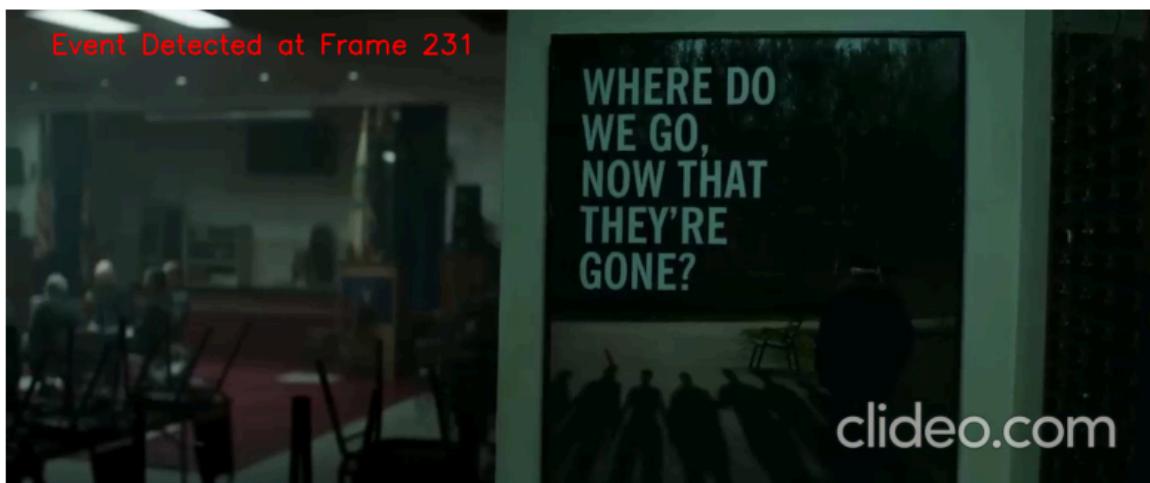
Event Detected at Frame 229



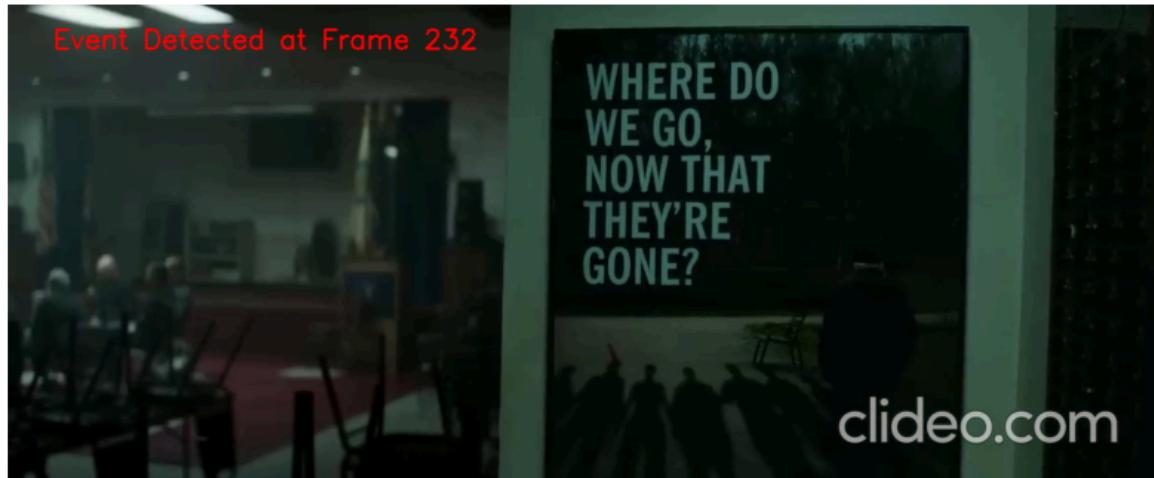
Event Detected at Frame 230



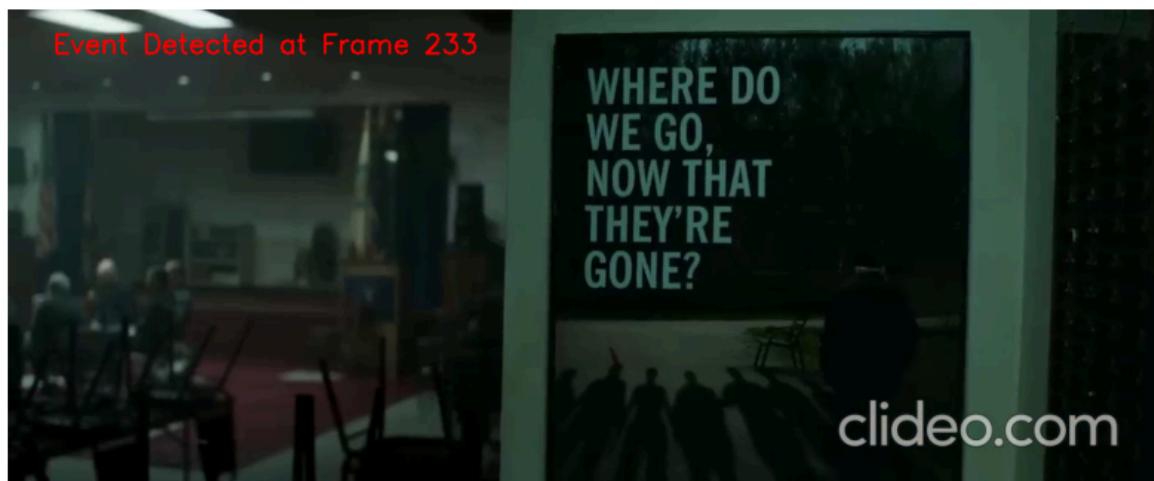
Event Detected at Frame 231



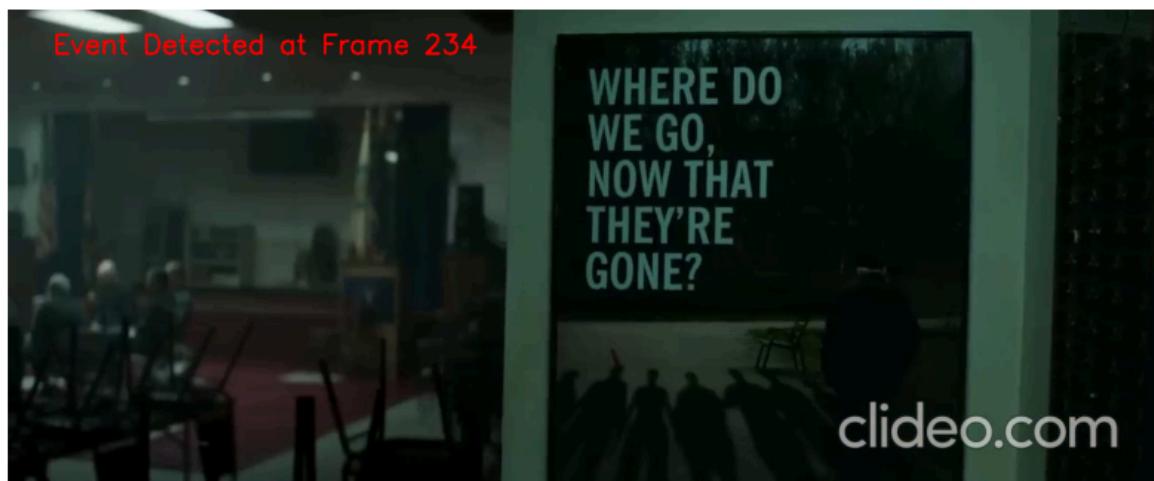
Event Detected at Frame 232



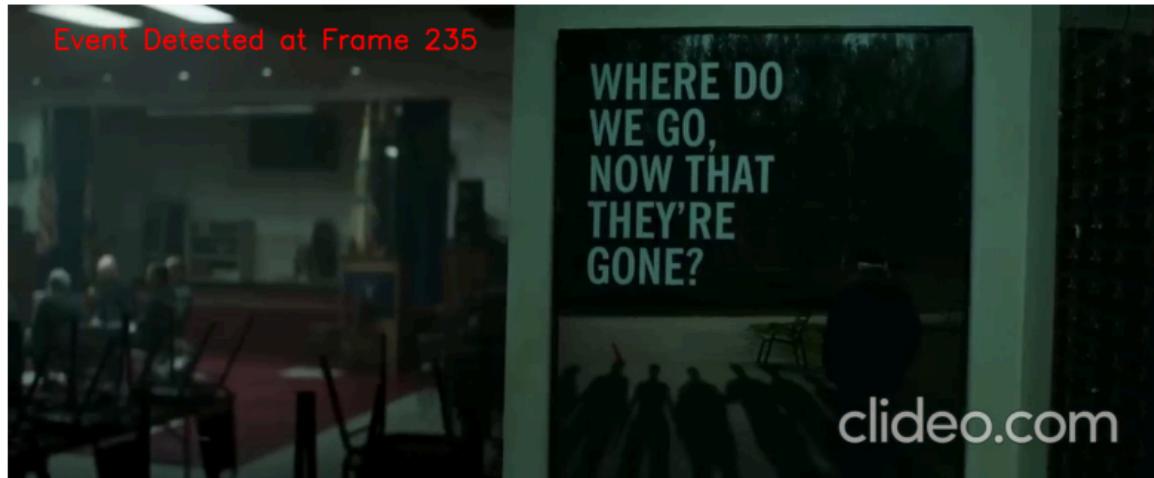
Event Detected at Frame 233



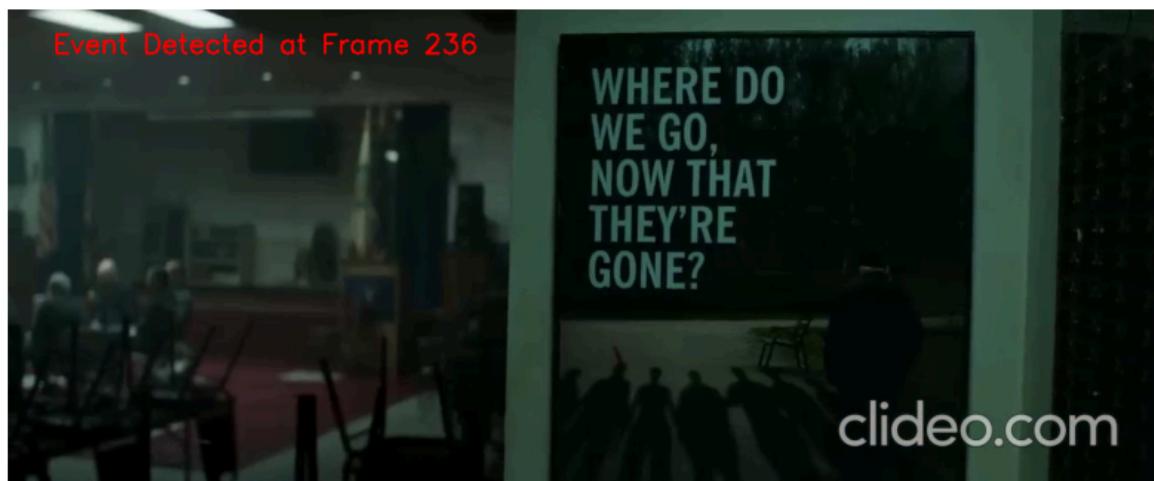
Event Detected at Frame 234



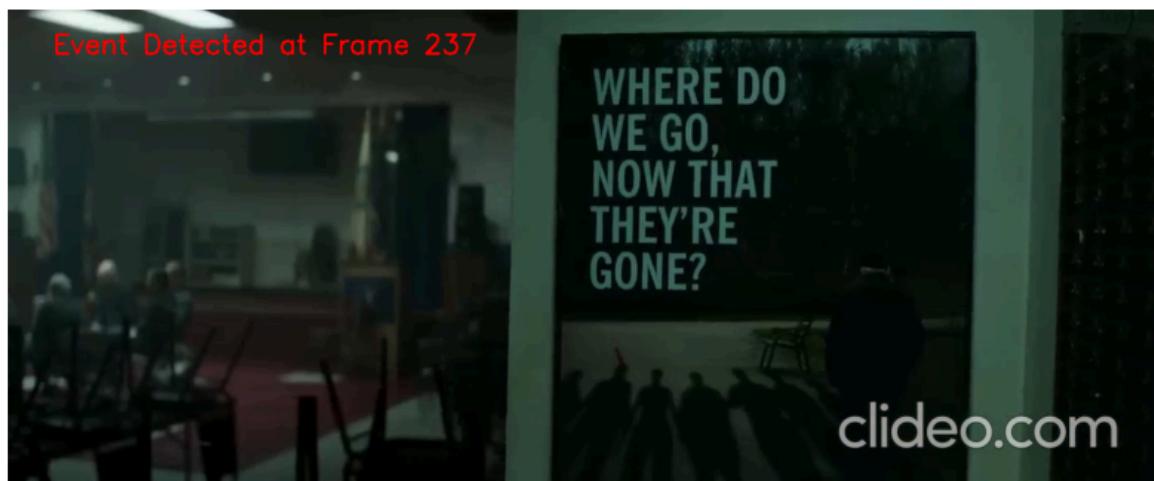
Event Detected at Frame 235



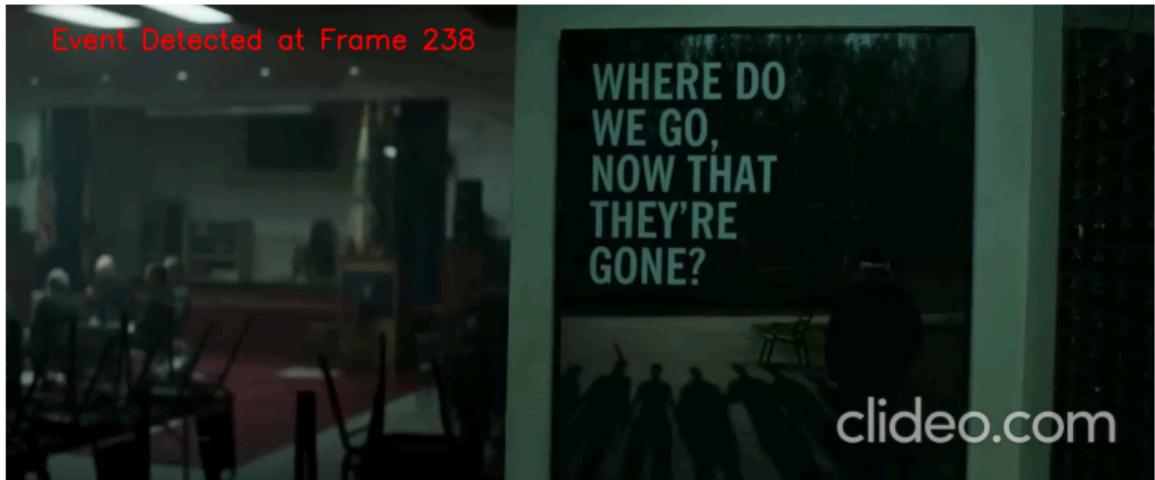
Event Detected at Frame 236



Event Detected at Frame 237



Event Detected at Frame 238



Visualization complete.

- The solution efficiently detected motion and highlighted significant events in the video using traditional computer vision techniques.
- Frames with significant motion were identified and displayed, helping users understand the moments of interest in the video.
- The approach was effective for simpler scenarios but may require fine-tuning of parameters (like thresholds) for more complex videos.

Github Link:

[https://github.com/TanishMahajan28/21BAI1187\\_MachineVisionLab](https://github.com/TanishMahajan28/21BAI1187_MachineVisionLab)