National College of Ireland

Configuration Manual

MSc Research Project
MSc Cloud Computing

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MSc Project Submission Sheet

School of Computing

Student Name:	Jatin Nikhil Dilliraj Saraswathy
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Programme:	MSc Cloud Computing **Year:** 2024-25
Module:	MSc Research Project
Lecturer:	Mr. Vikas Sahni
Submission Due Date:	03/01/25
Project Title:	Traffic signal optimisation and control using deep learning framework deployed over cloud for a connected Traffic Management
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Signature:	Jatin Nikhil
Date:	03/01/25

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Configuration Manual

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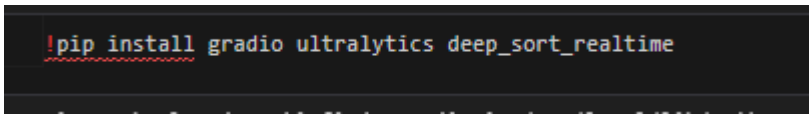
1 System Requirements

RAM: 16-32 GB SSD
OS: Windows 11 / Ubuntu 20.0.x +
Environment: AWS/Google Colab

2 Steps to Execute:

Step 1: Enter the URL
Step 2: Input a video or traffic image
Step 3: Observe the Gradio output
Step 4: Check the vehicles count

3 Vehicle Count Config File



The code snippet installs three Python libraries using the `pip` command:

1. `gradio`: A library to build web-based user interfaces for machine learning models.
2. `ultralytics`: A package related to the YOLO (You Only Look Once) object detection framework.
3. `deep_sort_realtime`: A library for real-time multi-object tracking using the Deep SORT algorithm.

```python
import cv2
import pandas as pd
import gradio as gr
from ultralytics import YOLO
import numpy as np

# Initialize the YOLO model
model = YOLO('yolo11n.pt')

# Define vehicle classes to track
vehicle_classes = ['car', 'motorcycle', 'bus', 'truck']

# Function to process video and count vehicles crossing the red line
def process_video_with_counting(video_path):
    """
    Process a video to detect and count vehicles crossing a red line.
    """
    cap = cv2.VideoCapture(video_path)

    # Initialize variables
    count = 0
    counter_down = set()

    # Output video setup
    fourcc = cv2.VideoWriter_fourcc(*'mp4v')
    out = cv2.VideoWriter('output_annotated_video.mp4', fourcc, cap.get(cv2.CAP_PROP_FPS),
                          (int(cap.get(cv2.CAP_PROP_FRAME_WIDTH)), int(cap.get(cv2.CAP_PROP_FRAME_HEIGHT))))

    while cap.isOpened():
        ret, frame = cap.read()
        if not ret:
            break
        count += 1

        # Perform object detection
        results = model(frame)
        if len(results) > 0:
            a = results[0].boxes.data
            a = a.detach().cpu().numpy()
            px = pd.DataFrame(a).astype("float")

            list = []
            for index, row in px.iterrows():
                x1 = int(row[0])
                y1 = int(row[1])
                x2 = int(row[2])
                y2 = int(row[3])
                d = int(row[5])
                c = model.names[d]
                if c in vehicle_classes:  # Filtering only vehicle types
                    list.append([x1, y1, x2, y2])
```

This code snippet processes a video to detect and count vehicles crossing a red line.

1. **Imports and Initialization:**
   - Libraries like `cv2`, `pandas`, and `gradio` are imported for video processing, data handling, and building interfaces.
   - A YOLO model is initialized with a pre-trained weight file (`yolov8n.pt`).
   - Vehicle classes of interest are defined as `['car', 'motorcycle', 'bus', 'truck']`.
2. **`process_video_with_counting` function:**
   - This function takes a video file path as input and analyzes each frame to detect vehicles.

- Sets up the video writer to save annotated output (`output_annotated_video.mp4`).
- Reads each frame and processes it using the YOLO model for object detection.

3. **Object Detection:**
   - The YOLO model returns bounding box predictions for objects in the frame.
   - Filters out predictions to keep only those matching the defined vehicle classes.
   - Coordinates of detected vehicles are stored in a list for further processing.

```
            # Process detected vehicles in the frame
            for x1, y1, x2, y2 in list:
                # Get the center of the bounding box
                cx = (x1 + x2) // 2
                cy = (y1 + y2) // 2

                # Check if the vehicle crosses the red line (Y=308)
                y = 308
                offset = 7
                if y < (cy + offset) and y > (cy - offset):
                    # Count this vehicle as crossing the red line
                    counter_down.add(f"{cx}_{cy}")  # Using a unique center point as ID for counting

        # Draw the red line
        red_color = (0, 0, 255)
        cv2.line(frame, (282, 308), (1004, 308), red_color, 3)
        cv2.putText(frame, 'Red line', (280, 308), cv2.FONT_HERSHEY_SIMPLEX, 0.5, (255, 255, 255), 1, cv2.LINE_AA)

        # Display count of vehicles that crossed
        downwards = len(counter_down)
        cv2.putText(frame, f'Going down - {downwards}', (60, 40), cv2.FONT_HERSHEY_SIMPLEX, 0.5, red_color, 1, cv2.LINE_AA)

        # Write the frame to output video
        out.write(frame)

    cap.release()
    out.release()

    # Return annotated video and vehicle count
    return 'output_annotated_video.mp4', f'Vehicles going down: {len(counter_down)}'

def count_and_detect_vehicles(image):
    """
    Detect and count vehicles in an image.
    """
    # Perform object detection
    results = model(image)

    # Count vehicles
    vehicle_counts = {}

    # Create a copy of the image for annotation
    annotated_image = image.copy()

    # Draw bounding boxes and count vehicles
    for result in results:
        boxes = result.boxes

        for box in boxes:
            # Get class details
            cls = model.names[int(box.cls[0])]

            # Check if it's a vehicle class
            if cls in vehicle_classes:
                # Increment count
                vehicle_counts[cls] = vehicle_counts.get(cls, 0) + 1
```

his part of the code builds on the vehicle detection logic to count vehicles crossing a specific line (red line) in a video and also includes functionality to process images for vehicle detection. Here's a concise explanation:

1. Processing Detected Vehicles in Frames:

- For each detected vehicle's bounding box, the center point `(cx, cy)` is calculated.
- If the center point crosses the defined red line (at `y=308` with an offset), the vehicle is counted and logged in `counter_down` to ensure each vehicle is counted only once.

2. Annotating the Frame:

- The red line is drawn on the video frame to visualize the detection threshold.
- Displays the count of vehicles that have crossed the line (`Going down`).
- The annotated frame is written to the output video.

3. Finalizing Video Output:

- Releases video resources and returns the annotated video file and the total vehicle count.

4. `count_and_detect_vehicles` Function:

- Detects vehicles in a single image using the YOLO model.
- Counts the detected vehicles and groups them by type (e.g., car, bus).

- Annotates the image with bounding boxes and the count of detected vehicles.

```
                # Get bounding box coordinates
                x1, y1, x2, y2 = box.xyxy[0]
                x1, y1, x2, y2 = int(x1), int(y1), int(x2), int(y2)

                # Draw rectangle
                color = (np.random.randint(0, 255),
                         np.random.randint(0, 255),
                         np.random.randint(0, 255))
                cv2.rectangle(annotated_image, (x1, y1), (x2, y2), color, 2)

                # Put class label
                label = f"{cls}"
                cv2.putText(annotated_image, label, (x1, y1 - 10),
                            cv2.FONT_HERSHEY_SIMPLEX, 0.9, color, 2)

    # Prepare vehicle count text
    count_text = "\n".join([f"{vehicle}: {count}" for vehicle, count in vehicle_counts.items()])

    return annotated_image, count_text

def interface():
    """
    Create a Gradio interface for vehicle counting on images and videos.
    """
    def process_input(input_type, input_value):
        if input_type == "image":
            # Read the uploaded image
            image = cv2.imread(input_value)
            if image is None:
                return None, None, "Error: Unable to read the uploaded image."
            annotated_image, vehicle_count = count_and_detect_vehicles(image)
            return annotated_image, None, vehicle_count
        elif input_type == "video":
            # Handle video input and ensure proper format
            if isinstance(input_value, str):
                annotated_video, vehicle_count = process_video_with_counting(input_value)
                return None, annotated_video, vehicle_count
            else:
                return None, None, "Error: Unsupported video format."
        else:
            return None, None, "Error: Invalid input type."

    demo = gr.Interface(
        fn=process_input,
        inputs=[
            gr.Radio(["image", "video"], label="Input Type", value="image"),
            gr.File(type="filepath", label="Upload Image/Video")
        ],
        outputs=[
            gr.Image(label="Annotated Image (for Images Only)"),
            gr.Video(label="Annotated Video (for Videos Only)"),
            gr.Textbox(label="Vehicle Count")
        ],
        title="Vehicle Counting and Crossing Detection",
        description="Detect and count vehicles in images or videos. Vehicles crossing a red line in videos will be tracked."
    )
    return demo

# Launch the Gradio interface
if __name__ == "__main__":
    app = interface()
    app.launch(debug=True)
```

This part of the code integrates the detection and counting logic into a Gradio web interface for ease of use. Here's a concise breakdown:

1. Bounding Box and Annotations:

- For each detected object, a bounding box is drawn with a randomly chosen color.
- The class label (e.g., "car", "bus") is displayed above the bounding box.
- The vehicle count by type is prepared as a summary text (`count_text`).

2. Gradio Interface (`interface` function):

- Defines a `process_input` function to handle both image and video inputs:
  - **Image:** Reads and processes the uploaded image for vehicle detection, returns the annotated image and vehicle count.
  - **Video:** Processes the uploaded video for vehicle detection and tracking, returns the annotated video and count.
  - Handles unsupported file types with an error message.
- Sets up a Gradio interface with:
  - Inputs: A radio button to select between "image" or "video" and a file upload component.
  - Outputs: Displays the annotated image/video and a textbox with the vehicle count.

3. Launching the Gradio App:

- The `interface` function is called, and the Gradio app is launched with debug mode enabled.

References

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