

Intel Unnati 2025 Project Report

Title: DL Streamer Pipeline: Real-time Multi-Stream Detection and Classification

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1. Problem Statement Overview

Develop a pipeline using Intel DL Streamer that can:

- Decode video streams
 - Perform object detection and classification
 - Scale efficiently across multiple video streams
 - Measure and report FPS to evaluate system scalability on Intel hardware
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2. Tools & Technologies Used

- **DL Streamer:** Intel's Deep Learning Streamer (GStreamer plugins)
 - **Docker:** For running DL Streamer container
 - **OpenVINO:** For optimized inference
 - **Models Used:**
 - person-detection-retail-0013 (for detection)
 - vehicle-attributes-recognition-barrier-0039 (for classification)
 - **OS:** Ubuntu (inside Docker)
 - **Input Video:** Real-world .mp4 streams used for final testing
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3. Pipeline Architecture

Each stream follows this pipeline:

Video File (.mp4)

↓

filesrc → decodebin → gvadetect → gvaclassify → gvawatermark → videoconvert → fpsdisplaysink

All streams run in parallel using separate branches in the same GStreamer pipeline.

4. Experimental Setup

- **Test videos:** 60s .mp4, real-world streams, 640x480 resolution, 30fps
- **Execution method:** gst-launch-1.0 with fpsdisplaysink
- **Monitoring:** GST_DEBUG=fpsdisplaysink:5 to extract min/max/avg FPS

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- **System Load:** Monitored via top

5. System Specifications

| Component | Specification |
|----------------|--|
| Laptop Model | Lenovo LOQ |
| CPU | Intel Core i5-13420H (12th Gen, 8 Cores) |
| Base Frequency | 2.10 GHz |
| | |
| Max Turbo | 4.60 GHz |
| Threads | 12 Threads |
| RAM | 16 GB DDR5 |
| Storage | 512 GB NVMe SSD |
| iGPU | Intel UHD Graphics (0x468b) |
| OS (WSL2) | Ubuntu 22.04 on Windows 11 (Build 26100) |
| WSL Kernel | 6.6.87.2-microsoft-standard-WSL2 |
| Docker | Docker Desktop with WSL2 backend |

6. Performance Results

FPS and CPU usage per stream:

| Streams | Avg FPS/Stream | Total FPS | CPU Load |
|---------|----------------|-----------|----------|
| 1 | 38.0 | 38.0 | ~25% |
| 2 | 37.9 | 75.8 | ~45% |
| 4 | ~15.3 | 61.3 | ~85–100% |

FPS Breakdown – 4 Streams:

| Stream | Max FPS | Min FPS | Avg FPS |
|----------|---------|---------|---------|
| Stream 1 | 17.60 | 10.96 | 15.15 |
| Stream 2 | 17.32 | 12.74 | 15.46 |
| Stream 3 | 17.51 | 11.77 | 15.31 |
| Stream 4 | 19.35 | 13.32 | 15.37 |

Comparison Analysis:

- From 1 to 2 streams, the system showed nearly **linear scaling** with minimal FPS loss.
- At 4 streams, **total FPS slightly dropped**, indicating CPU saturation.
- Despite the drop, real-time performance was sustained across all streams.

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7. Bottleneck & Scalability

As the number of streams increases, CPU becomes the bottleneck, with near 100% usage on 4 streams.

Recommendations:

- Switch to FP16 model precision
 - Leverage iGPU via device=GPU
 - Optimize with multi-threading or scheduling
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GPU Testing Challenges and Limitations

During the setup and testing of the DL Streamer pipeline, extensive efforts were made to utilize the integrated Intel GPU for hardware-accelerated inference. The following steps were taken:

1. Verified GPU presence and OpenCL support using ``clinfo``, which correctly identified the Intel UHD Graphics device.
2. Installed required Intel OpenCL, Level Zero, and VA-API media driver packages inside the WSL2 environment.
3. Attempted to execute DL Streamer pipelines with ``device=GPU``, which consistently failed due to ``/dev/dri`` not being accessible within WSL2.
4. Reconfigured BIOS settings (e.g., iGPU-only, Hybrid, dGPU modes) and ensured updated Intel Graphics drivers were installed on the Windows host.
5. Validated successful OpenCL setup from Windows side and tested CUDA setup independently for reference.

Despite these efforts, GPU inference through Intel DL Streamer inside WSL2 could not be executed due to WSL's current limitation of exposing GPU devices reliably for Intel iGPUs. As a result, DL Streamer GPU testing could not be completed within the WSL2 environment on this hardware setup.

Note: This limitation is specific to the Intel GPU and WSL2 interoperability in the current system configuration.

8. Observations & Optimization

- Good scaling up to 2 streams with negligible FPS drop
- Beyond 2 streams, CPU usage became a bottleneck
- For higher scalability:
 - Use FP16 models (lighter than FP32)

- Use Intel iGPU if available (device=GPU)
- Consider multithreading or stream scheduling

8. Screenshots / Logs (Appendix)

[illegible]

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```
not@octarine09: /home/...
0:00:03.805802268 2u 0x7f29c4a9da10 DEBUG fpsdisplaysink fpsdisplaysink.c:387:display_current_fps:<fps2> Updated min-fps to 19.626691
0:00:03.817978558 2u 0x7f29d1029320 DEBUG fpsdisplaysink fpsdisplaysink.c:383:display_current_fps:<fps1> Updated max-fps to 14.5
0:00:03.819112397 2u 0x7f29d1029320 DEBUG fpsdisplaysink fpsdisplaysink.c:387:display_current_fps:<fps1> Updated min-fps to 14.594371
0:00:03.821213728 2u 0x7f29d1029320 DEBUG fpsdisplaysink fpsdisplaysink.c:387:display_current_fps:<fps4> Updated min-fps to 11.635482
0:00:03.8319191236 2u 0x7f29c4a9da10 DEBUG fpsdisplaysink fpsdisplaysink.c:387:display_current_fps:<fps3> Updated min-fps to 15.829376
0:00:03.831919853 2u 0x7f29c4a9da10 DEBUG fpsdisplaysink fpsdisplaysink.c:383:display_current_fps:<fps2> Updated max-fps to 17.360539
0:00:03.840999949 2u 0x7f29d1029320 DEBUG fpsdisplaysink fpsdisplaysink.c:383:display_current_fps:<fps1> Updated max-fps to 15.298498
0:00:03.842278814 2u 0x7f29d1029320 DEBUG fpsdisplaysink fpsdisplaysink.c:383:display_current_fps:<fps4> Updated max-fps to 17.272431
0:00:04.839455974 2u 0x7f29c4a9da10 DEBUG fpsdisplaysink fpsdisplaysink.c:387:display_current_fps:<fps2> Updated min-fps to 15.115326
0:00:04.259983283 2u 0x7f29d1029320 DEBUG fpsdisplaysink fpsdisplaysink.c:383:display_current_fps:<fps1> Updated max-fps to 16.609829
0:00:04.773527827 2u 0x7f29d1029320 DEBUG fpsdisplaysink fpsdisplaysink.c:383:display_current_fps:<fps1> Updated max-fps to 17.522760
0:00:05.296377746 2u 0x7f29d1029320 DEBUG fpsdisplaysink fpsdisplaysink.c:387:display_current_fps:<fps1> Updated min-fps to 13.387861
0:00:05.576866938 2u 0x7f29c4a9da10 DEBUG fpsdisplaysink fpsdisplaysink.c:387:display_current_fps:<fps3> Updated min-fps to 13.631432
0:00:05.749729683 2u 0x7f29c4a9da10 DEBUG fpsdisplaysink fpsdisplaysink.c:387:display_current_fps:<fps2> Updated min-fps to 14.223749
0:00:06.875499251 2u 0x7f29d1029320 DEBUG fpsdisplaysink fpsdisplaysink.c:383:display_current_fps:<fps1> Updated max-fps to 19.486982
0:00:06.969517492 2u 0x7f29d1029320 DEBUG fpsdisplaysink fpsdisplaysink.c:383:display_current_fps:<fps4> Updated max-fps to 17.287363
0:00:07.361484885 2u 0x7f29c4a9da10 DEBUG fpsdisplaysink fpsdisplaysink.c:383:display_current_fps:<fps2> Updated max-fps to 19.410968
0:00:07.671481708 2u 0x7f29d1029320 DEBUG fpsdisplaysink fpsdisplaysink.c:383:display_current_fps:<fps4> Updated max-fps to 17.929179
0:00:08.387422238 2u 0x7f29d1029320 DEBUG fpsdisplaysink fpsdisplaysink.c:383:display_current_fps:<fps3> Updated max-fps to 19.848332
0:00:08.889126487 2u 0x7f29d1029320 DEBUG fpsdisplaysink fpsdisplaysink.c:383:display_current_fps:<fps4> Updated max-fps to 18.971223
0:00:10.219816341 2u 0x7f29d1029320 DEBUG fpsdisplaysink fpsdisplaysink.c:383:display_current_fps:<fps1> Updated max-fps to 19.651389
0:00:11.216367965 2u 0x7f29c4a9da10 DEBUG fpsdisplaysink fpsdisplaysink.c:383:display_current_fps:<fps2> Updated max-fps to 19.713654
0:00:12.523533881 2u 0x7f29c4a9da10 DEBUG fpsdisplaysink fpsdisplaysink.c:383:display_current_fps:<fps3> Updated max-fps to 20.407932

Got EOS from element "pipeline0".
Execution ended after 0:00:10.314658028
Setting pipeline to NULL ...
0:00:20.816811088 2u 0x582f1f9b27f0 DEBUG fpsdisplaysink fpsdisplaysink.c:504:fps_display_sink_stop:<fps4> Max-fps: 18.97, Min-fps: 11.64, Averag
e-fps: 16.32
0:00:20.816850164 2u 0x582f1f9b27f0 DEBUG fpsdisplaysink fpsdisplaysink.c:504:fps_display_sink_stop:<fps3> Max-fps: 20.49, Min-fps: 13.03, Averag
e-fps: 16.58
0:00:20.816878852 2u 0x582f1f9b27f0 DEBUG fpsdisplaysink fpsdisplaysink.c:504:fps_display_sink_stop:<fps2> Max-fps: 19.71, Min-fps: 14.22, Averag
e-fps: 16.66
0:00:20.816909445 2u 0x582f1f9b27f0 DEBUG fpsdisplaysink fpsdisplaysink.c:504:fps_display_sink_stop:<fps1> Max-fps: 19.65, Min-fps: 13.39, Averag
e-fps: 16.61
Freeing pipeline ...
root@octarine09: /home/distreamers |
```



Submitted by: Piyush Mishra
Date: 12th July , 2025