Traffic Signal Recognition and Application Algorithm for the Autonomous Vehicle in V2X Unable Areas

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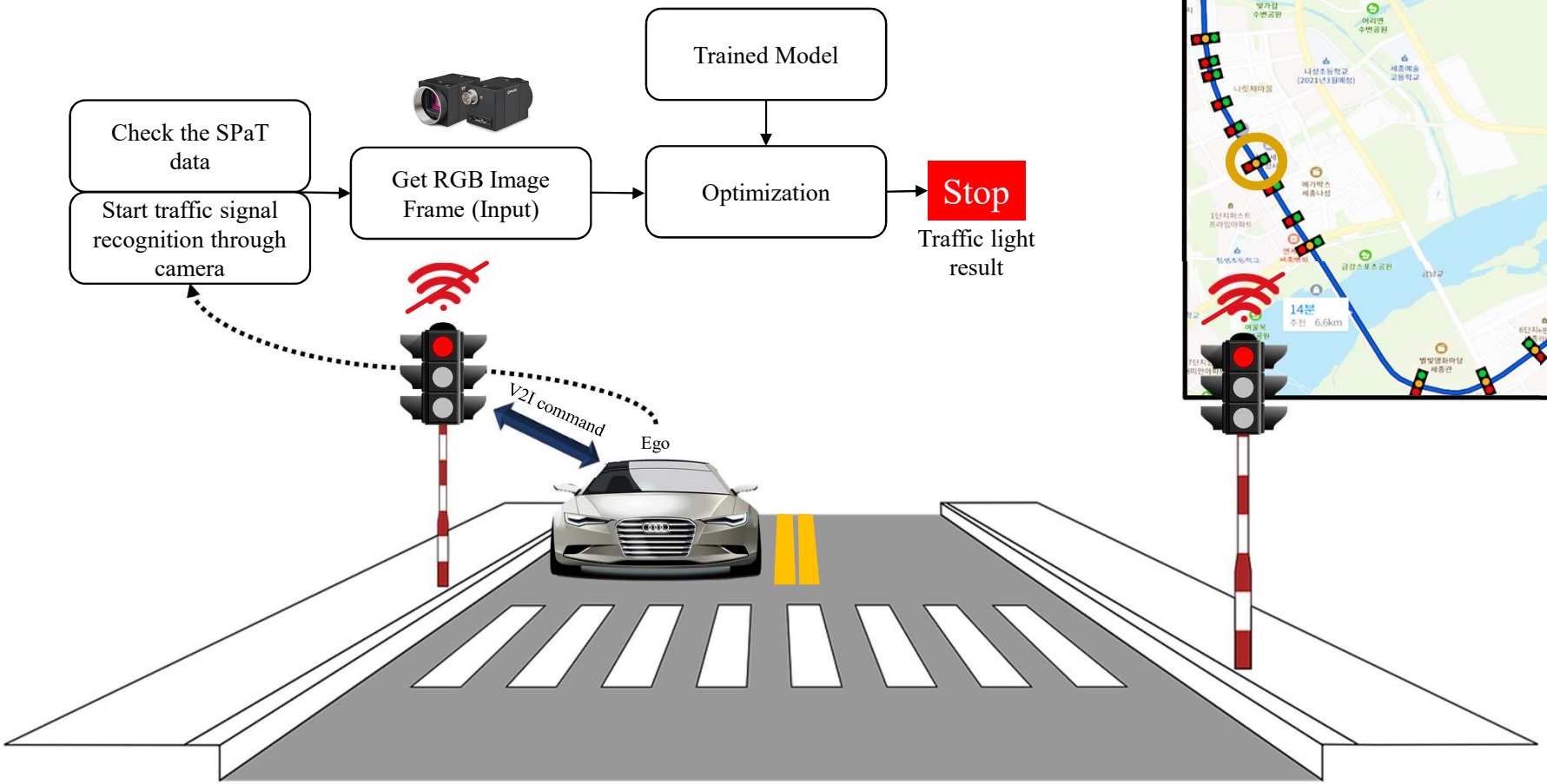
- Research interest:
  - Multi-sensor Fusion, Object Detection, Autonomous Engineering

Contents

Introduction



Related work

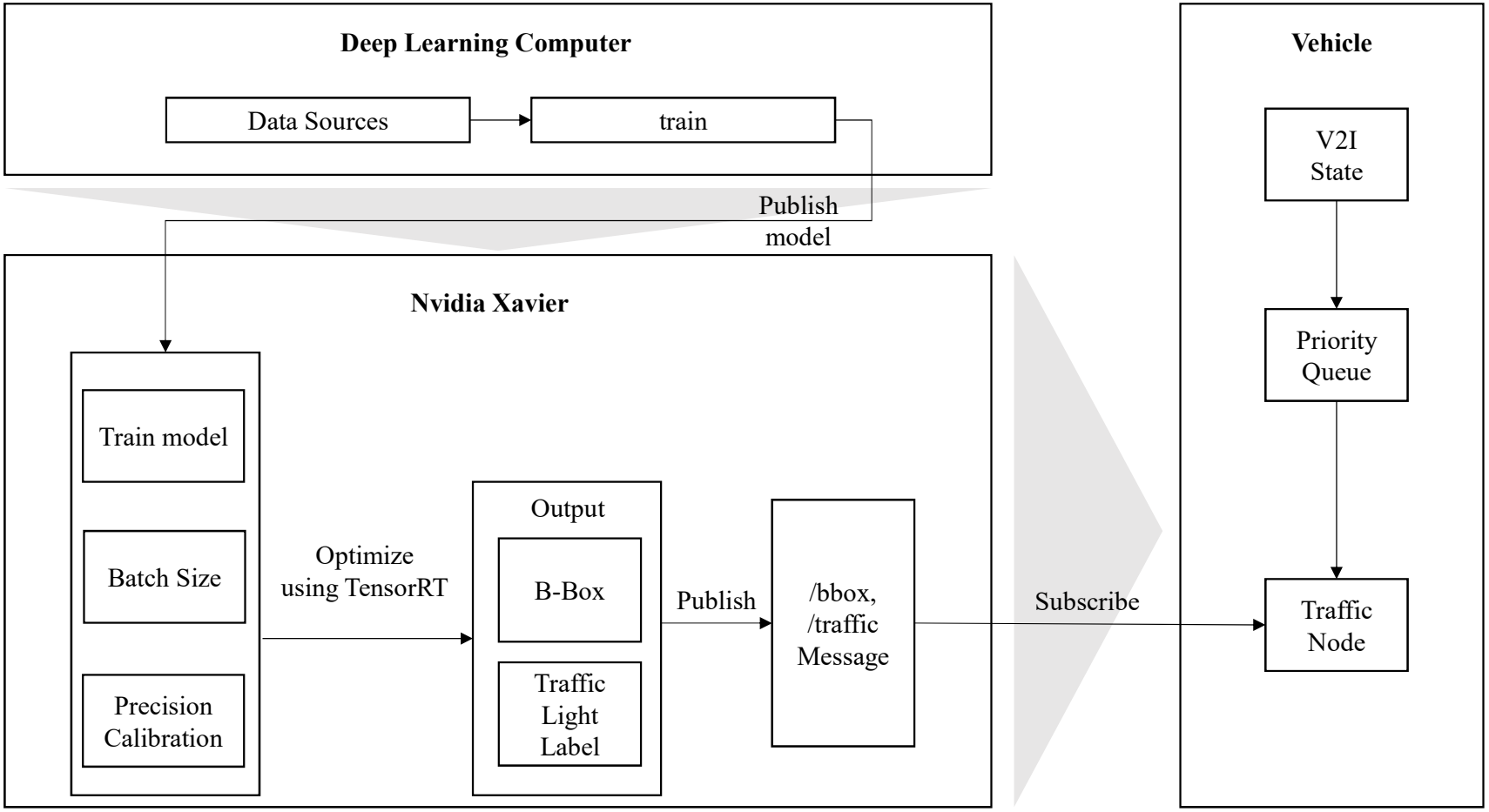
Statistics of the Open Datasets for Traffic Signal Recognition

Open dataset	Cities	Resolution [WxH]	Annotations	Classes
LaRA	Paris	640x480	9,168	4
LISA	San Diego	1280x960	51,826	7
BSTLD	Palo Alto	1280x720	24,242	4
DTLD	11 cities in Germany	2048x1024	292,245	5

Annotation

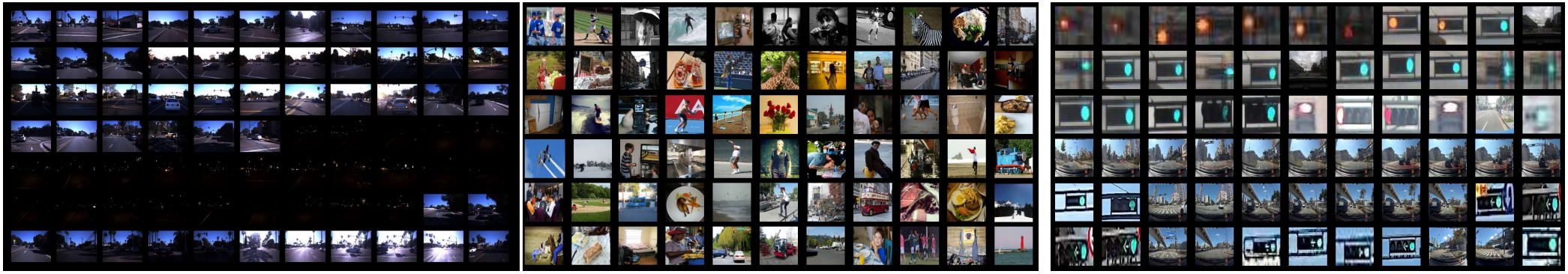
As far as we know, there have been studies on traffic signal recognition using images, the existing public dataset was not suitable for the target section of this study (Domain Problem).

Methodology



A. Data Construction

LISA Dataset + **COCO Dataset** + **Sejong City Demonstration Dataset**



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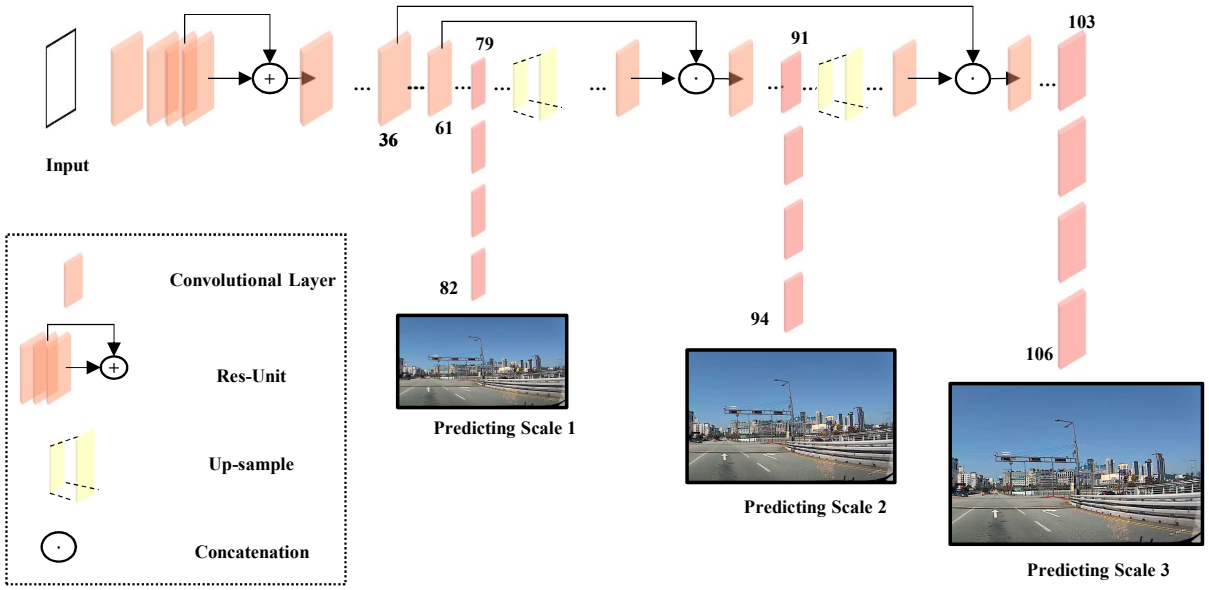
Training Data

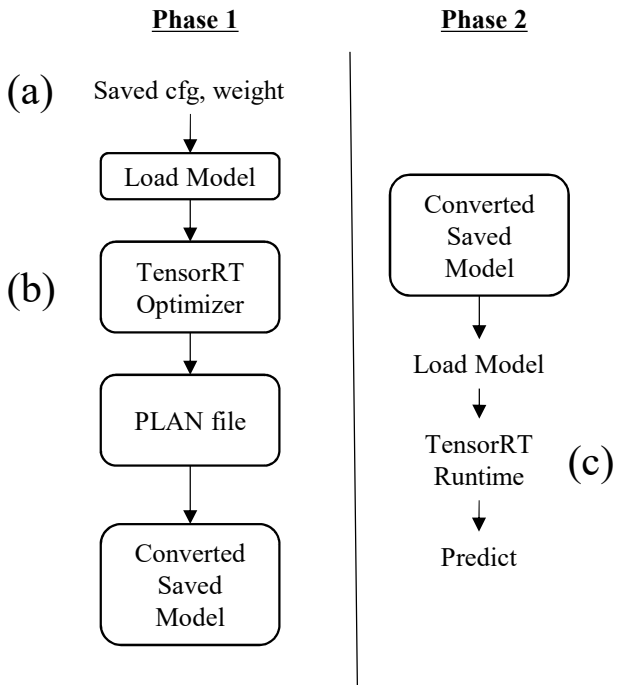
Traffic recognition system

Detection Model

- Bounding box
  = {x_center, y_center, box_width, box_height}
- This training model predicts boxes at three different scales.
- Each box vector size : (C+5)·B
  C : the num of classes
  B : the num of masks in one layer



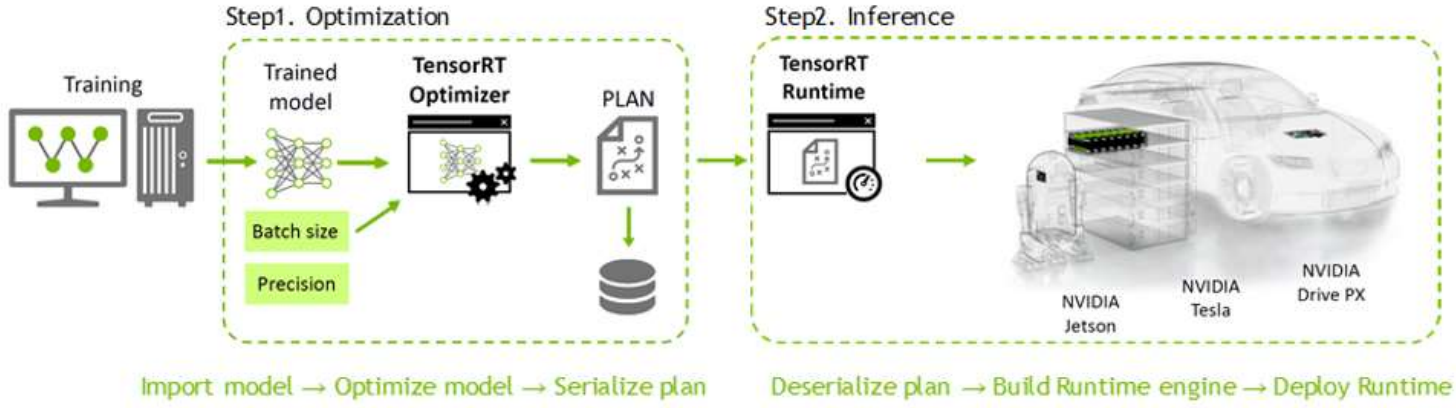
Real-time Inference Engine (Model Acceleration)



a. Train deep-learning model

b. Optimize the trained model using the TensorRT Optimizer

c. Through the TensorRT Runtime Engine, it runs with the optimal operation according to the NVIDIA GPU to be deployed.



NVIDIA, NVIDIA TensorRT-NVIDIA toolkit for inference optimization and acceleration. https://blogs.nvidia.co.kr/2020/02/19/nvidia-tensor-rt/

Traffic Signal Recognition using the Convergence of V2I and Camera Detection

- A camera captures an object and then extracts features and learns it from a deep learning model.
- ROS topic message can be transmitted to NVIDIA Xavier.
- $Needed\ Response\ Time = \frac{Braking\ distance}{Speed\ of\ Vehicle}$

Speed (km/h)	Braking distance (m)	Needed Response Time (s)
30	10	2.5
40	18	1.38

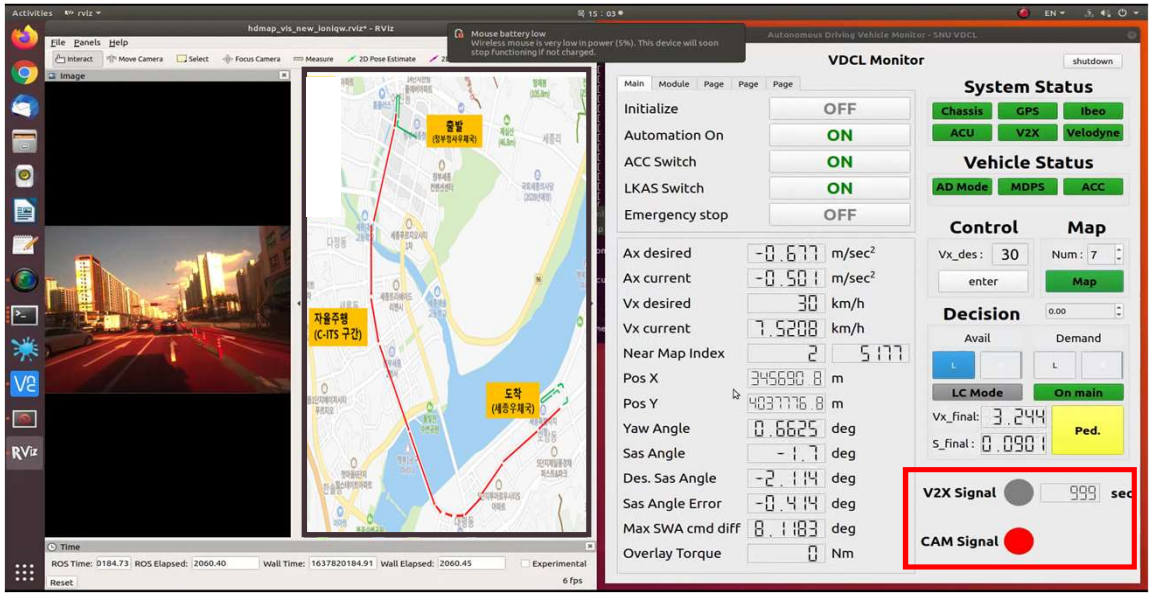
Algorithm 1 Traffic Light State Communication Algorithm

```
Data: raw camera image in C;
      stand-by time tick;
Result: traffic light state topic
initialization;
 while C is not empty do
  detect traffic light;
   publish traffic light state topic (Xavier);
   Calculate ticktime;
  if tick >1.5 then
subscribe traffic light state topic (Xavier → Vehi cle) ;
  end
 end
```

Implementation Details

Frame Difference between Standard and TensorRT

type	FPS
Without tensorRT	6.6
Adjust tensorRT	14.9



Conclusion

- We proposed a traffic light recognition algorithm that applied TensorRT to minimize image resource usage in the area where V2I is unabled.
- Performance was analyzed based on real-world scenarios tested in neural networks.
- As a result of our experiments, our algorithm was able to accelerate in terms of speed with the same accuracy.

Thank you for your interest.

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