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**An Embedded Deep Learning-based Package
for Traffic Law Enforcement**

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Introduction

As the number of automobiles on the road has risen in recent years, traffic violations have become more common.

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Importance of work

The probability of a fatality when an HGV is involved in an accident is multiplied by 2.6

Methodology

The proposed system includes four main steps of lane detection, HGV detection, license plate detection, and finally plate character recognition.
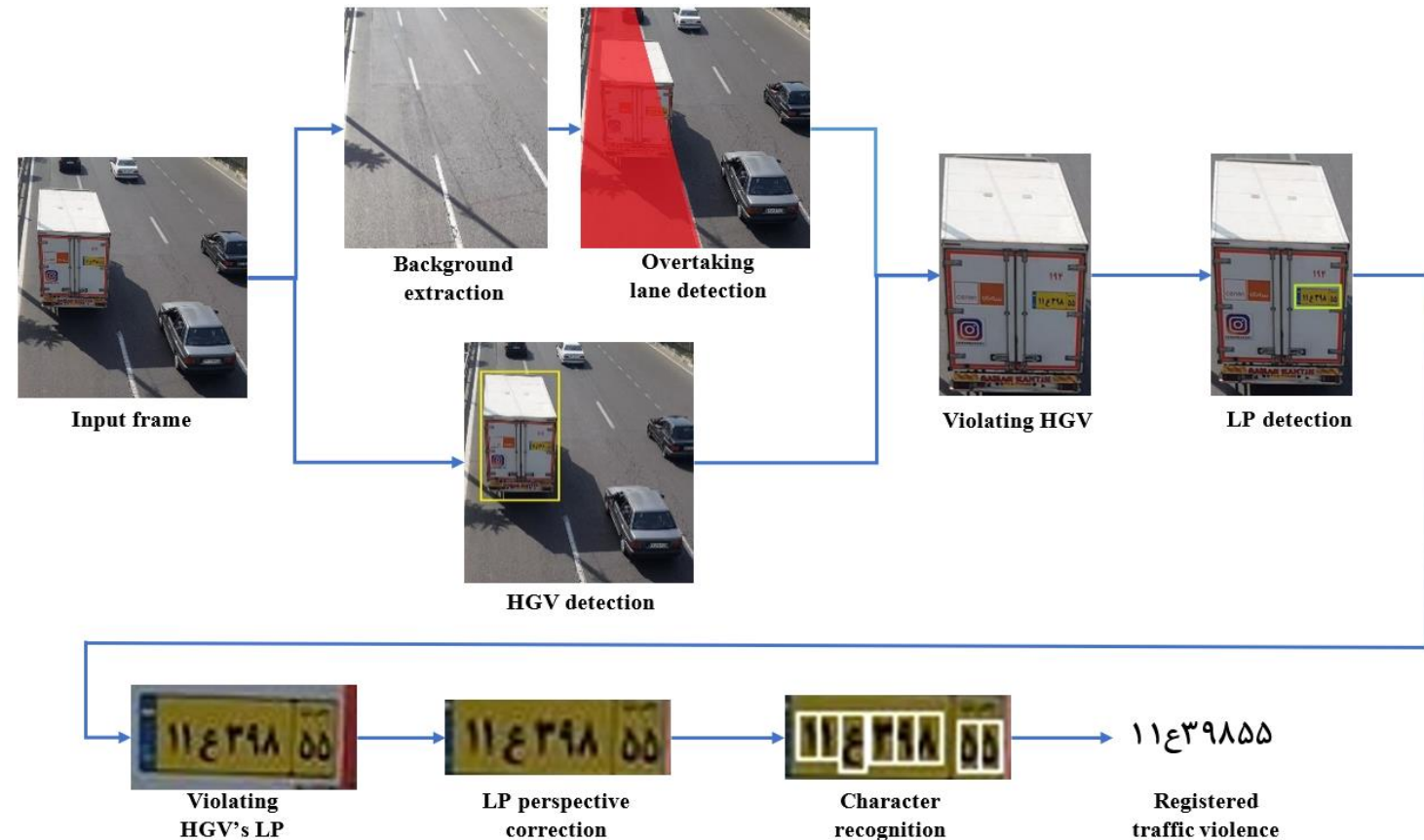
Input frame — Background extraction — Overtaking lane detection — HGV detection — Violating HGV — LP detection — Violating HGV's LP — LP perspective correction — Character recognition — Registered traffic violence

Overtaking Lane Detection

Flow diagram of overtaking lane detection:
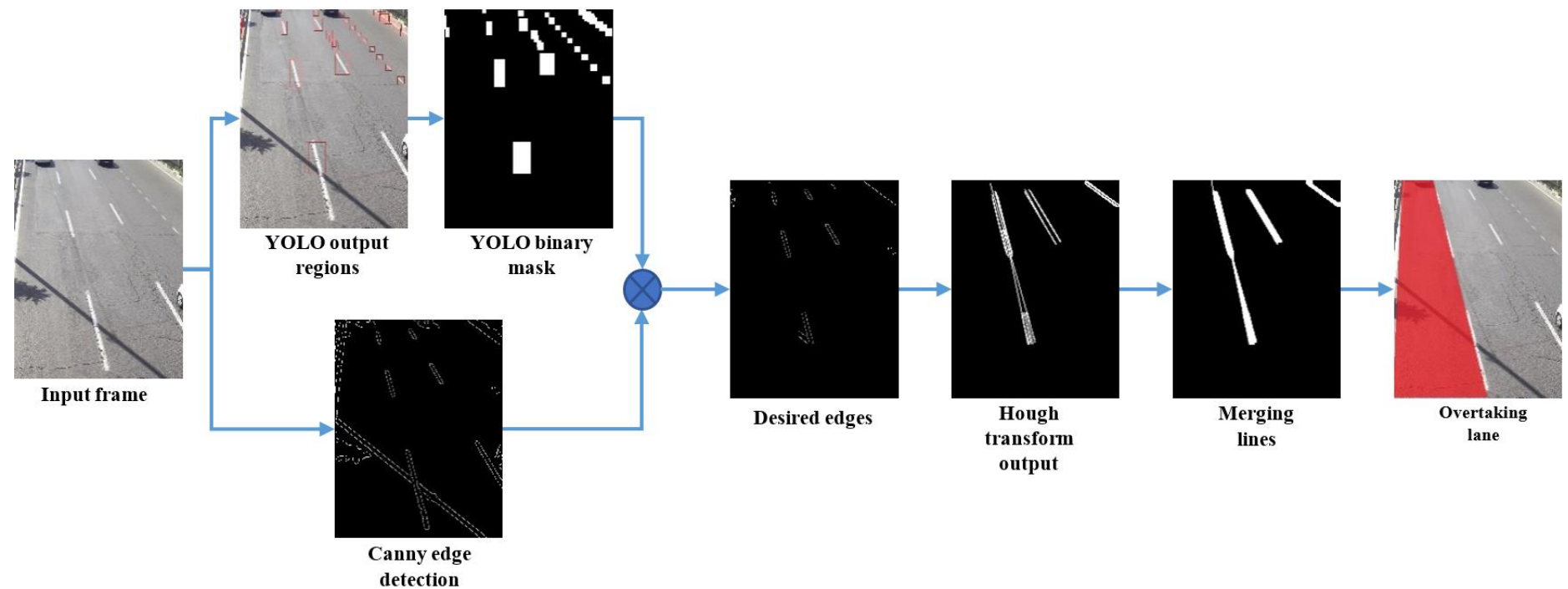
Input frame

YOLO output regions

YOLO binary mask

Canny edge detection

Desired edges

Hough transform output

Merging lines

Overtaking lane

HGV Detection

Detecting all the heavy vehicles by a YOLO network and comparing the vehicle's bounding box center with the overtaking lane mask

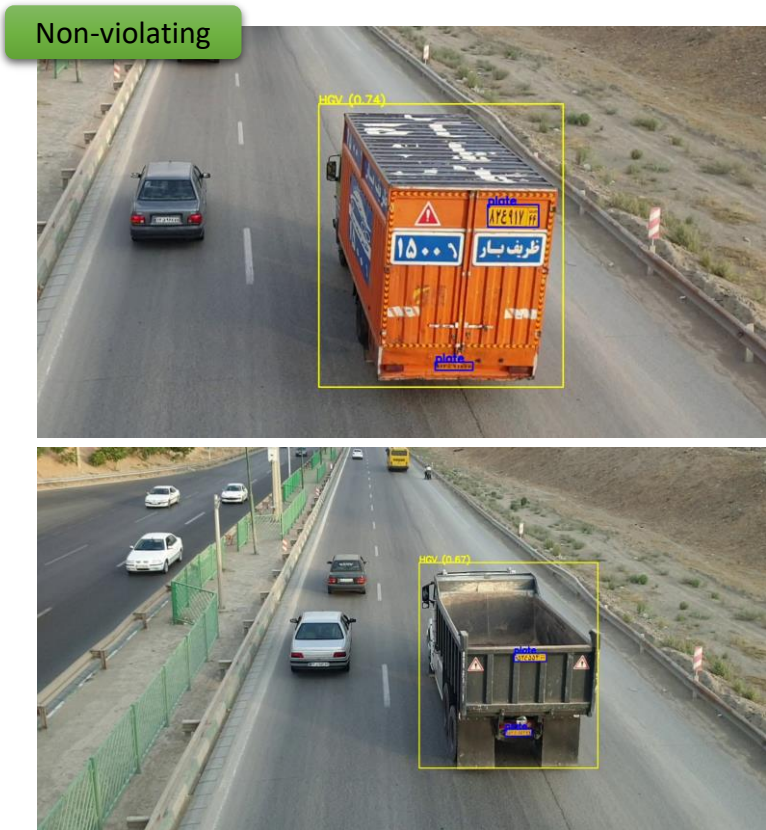# Plate Detection

First Step (LP Detection):

Second Step (Perspective Correction):
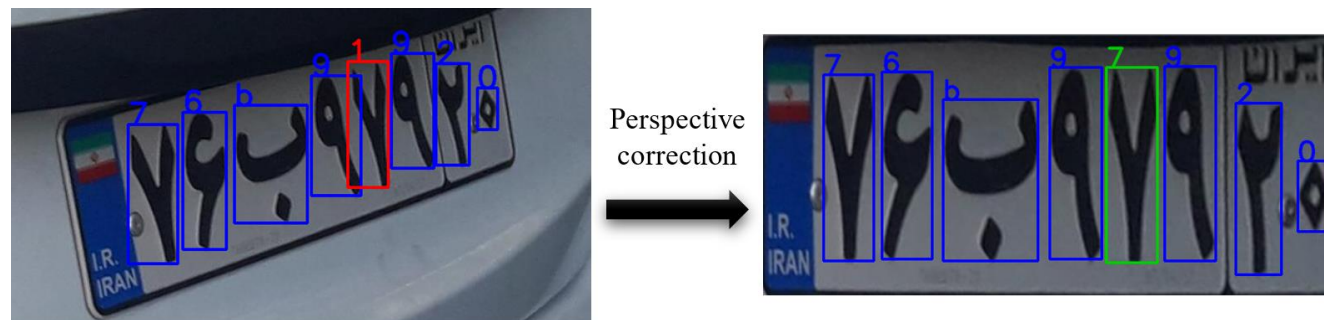
Perspective correction

Character Recognition

- Determining the identity of the violating HGV by recognizing the license plate characters.

$$\{(a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8) \,|\, x(a_i) < x(a_{i+1})\}$$

- Several datasets of Persian license plates are gathered for the YOLO network training
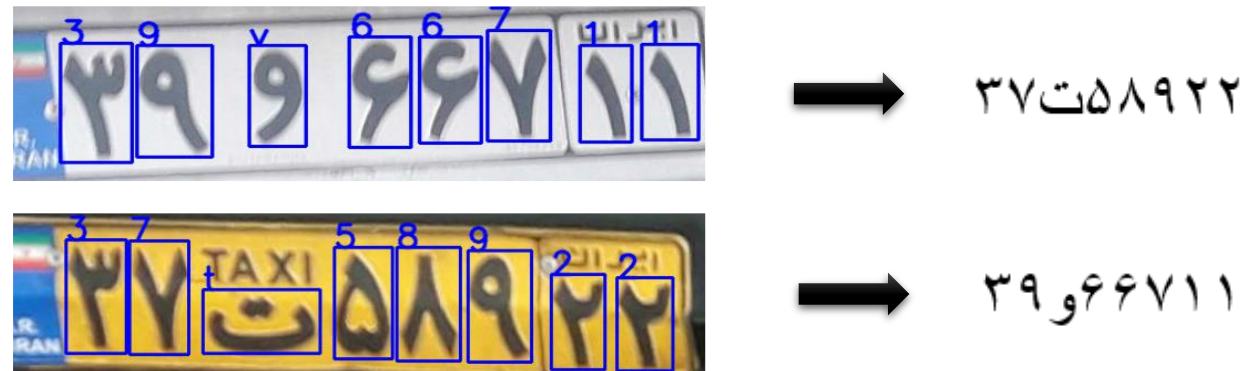
Dataset

Dataset used in this research, is composed of 4 parts:

- Overtaking Lane Dataset
- HGV Dataset
- License Plate Dataset
- Plate Character Dataset

Overtaking Lane Dataset

- 150 London traffic camera videos
- 295 local images of Iran taken by the embedded camera

HGV Dataset

- Pretrained on COCO dataset
- Fine-tuned on local dataset

License Plate Dataset

- local dataset with 295 photos of various cars in Iran with Persian license plates

Plate Character Dataset

- 10105 Persian license plates with character classes and bounding boxes
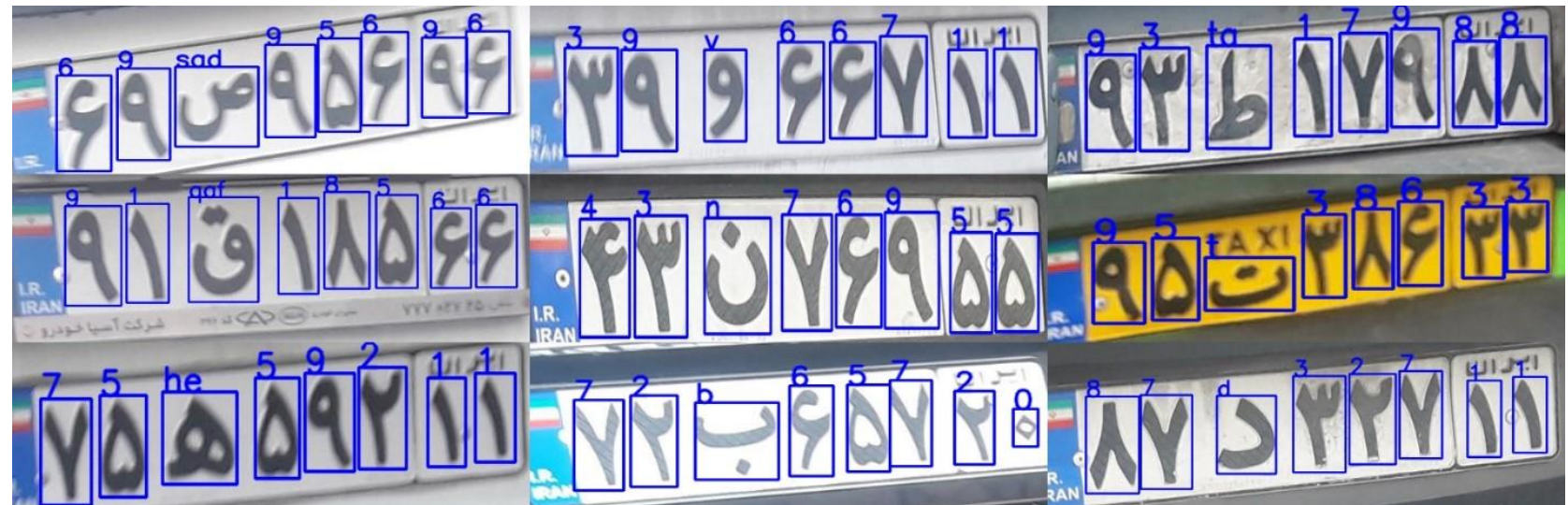
Hardware Configuration

NVIDIA Jetson Nano

- GPU: NVIDIA Maxwell with 128 NVIDIA CUDA® cores
- CPU: Quad-core ARM Cortex-A57 processor
- Memory: 4 GB 64-bit LPDDR4
- Storage: 16 GB eMMC 5.1
- Camera: 2 x MIPI CSI-2

Waveshare IMX477-160 12.3MP Camera

- MIPI-CSI Camera
- based on Sony IMX477 sensor
- 12.3 MP resolution

Results

Overtaking lane evaluation:

	IoU	Accuracy
Overtaking lane	0.881	93.1%

Results

Other stages evaluations:

Stage	Precision	Recall	F1	Accuracy
HGV	93.7%	95.7%	94.7%	90.0%
License plate	93.8%	91.5%	92.6%	86.2%
Character	93.5%	94.0%	93.7%	88.2%

Stage outputs:
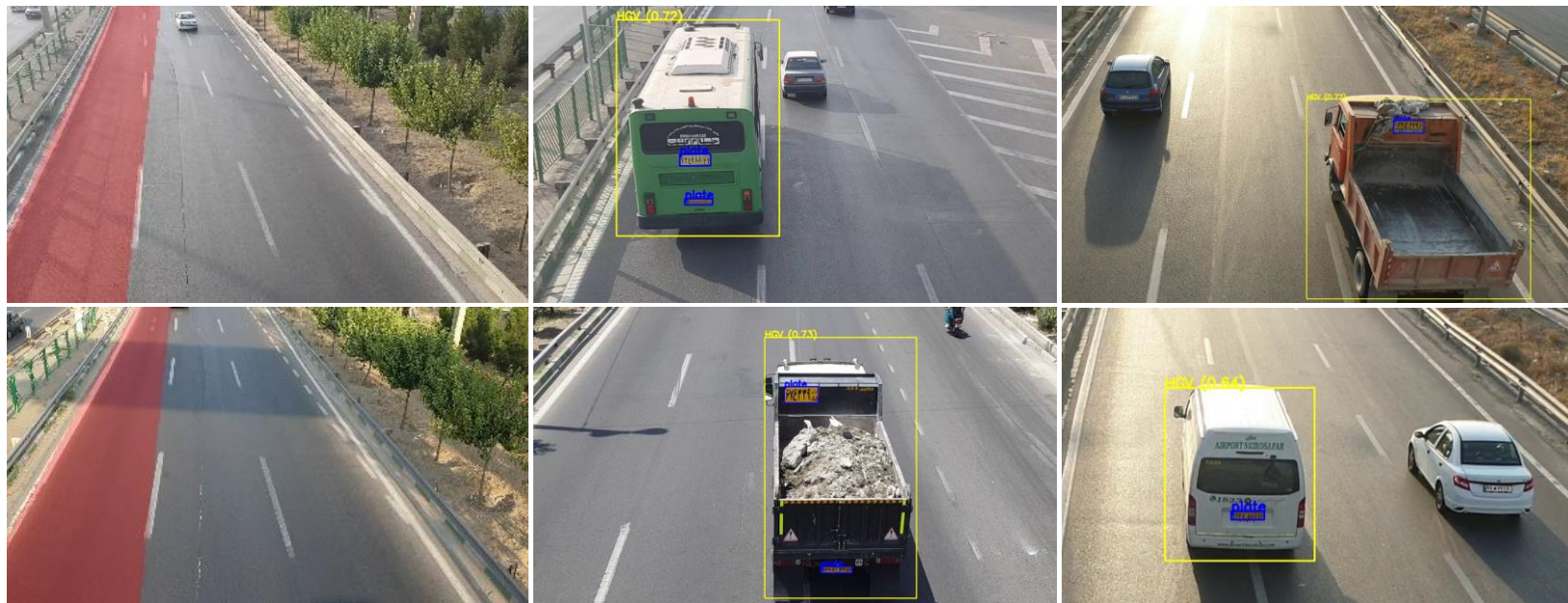
Results

Overall system evaluation:

	Precision	Recall	F1	Accuracy
Proposed method	96.9%	72.1%	82.7%	70.5%

Overall system outputs: