P9

Autoencoder-based Compression for Automotive Lighting System

Aymane HANINE (1), Yasser ALMEHIO, Ph.D (2)

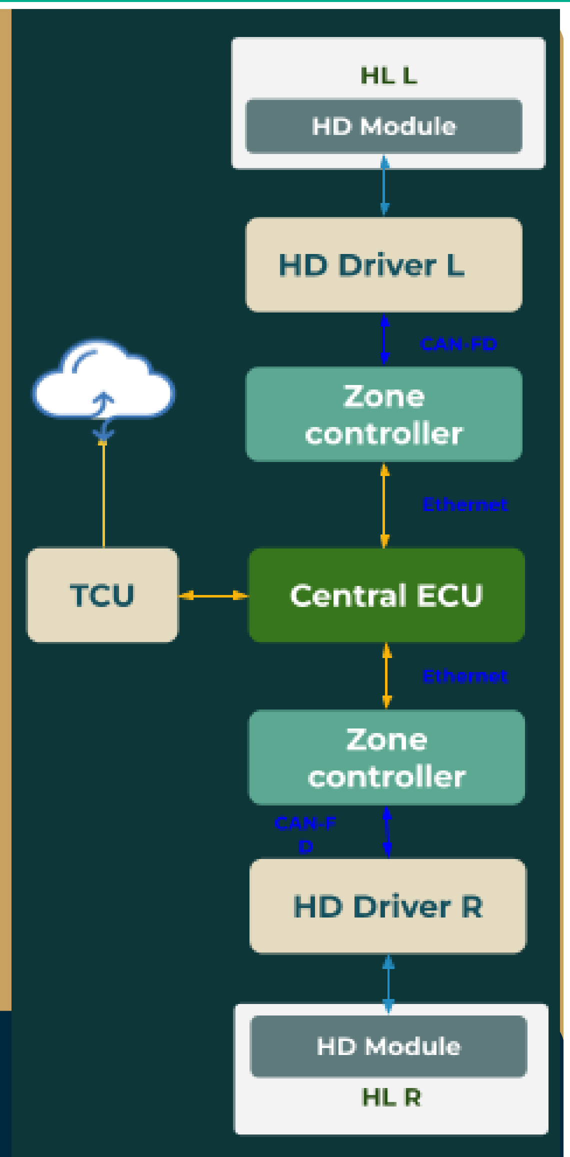
(1) Final year Data Science Engineering student, Ecole Centrale Casablanca (0637925446)
(2) Computer Vision Technical leader, Valeo Expert in AI

1 - Introduction

In modern vehicles, the growing number of sensors and electronic control units (ECUs) generates a large amount of data that needs to be transmitted efficiently over networks like Ethernet and CAN. To address the issue of limited bandwidth, we propose a data compression approach using autoencoders that can be applied to all automotive data classes and transmitted over various mediums. Our approach has the potential to improve the efficiency of lighting data transmission while preserving the necessary level of image quality with minimal artifacts, in order to keep the photometries regulated. Automotive lighting regulations require a masterd amount of light

2 - Contexte

- Lighting systems in modern vehicles are becoming more complex and advanced, requiring advanced photometric features for use in autonomous and assisted driving.
- The increasing number of modules and functions in modern vehicles is generating more data traffic over networks like Ethernet and CAN, which can strain the transmission means.
- OEMs are seeking to maintain the use of CAN due to its low cost and high security.

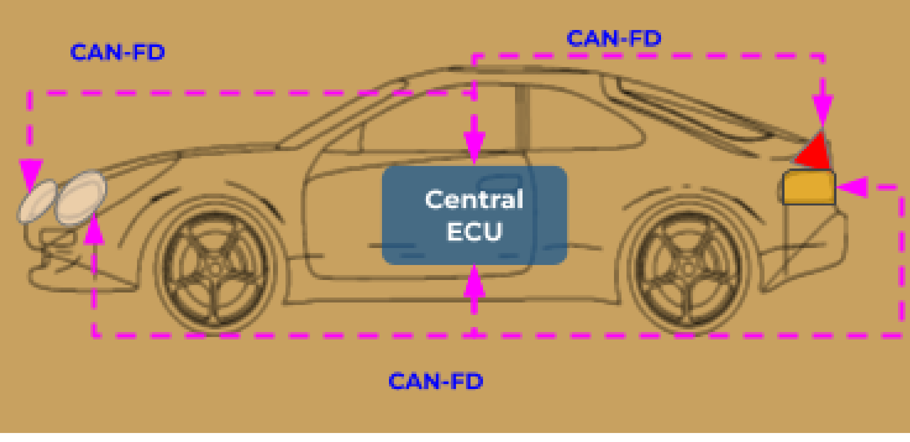


System architecture

3 - Goals

This project aims to deliver a solution that:

- Transmit photometric data of light @50fps between a central light controller and a 25K HD SSL over CAN-FD.
- Adhere to system constraints: current CAN-FD standards support only a bandwidth of 2 Mbit/s limits, and the data must be encoded on 8 bits.
- Achieve a compression rate of at least 88% (90% of bus load) without any artefacts.
- Generalize well to other use cases with a lower complexity.



4 - Approach

Our approach involves the use of autoencoders to compress photometric images for efficient transmission over a CAN-FD bus through four steps:

Data Generation

Generation of photometric data that follows standard lighting regulations and includes all necessary functional features for dynamic lighting.

Autoencoder V1

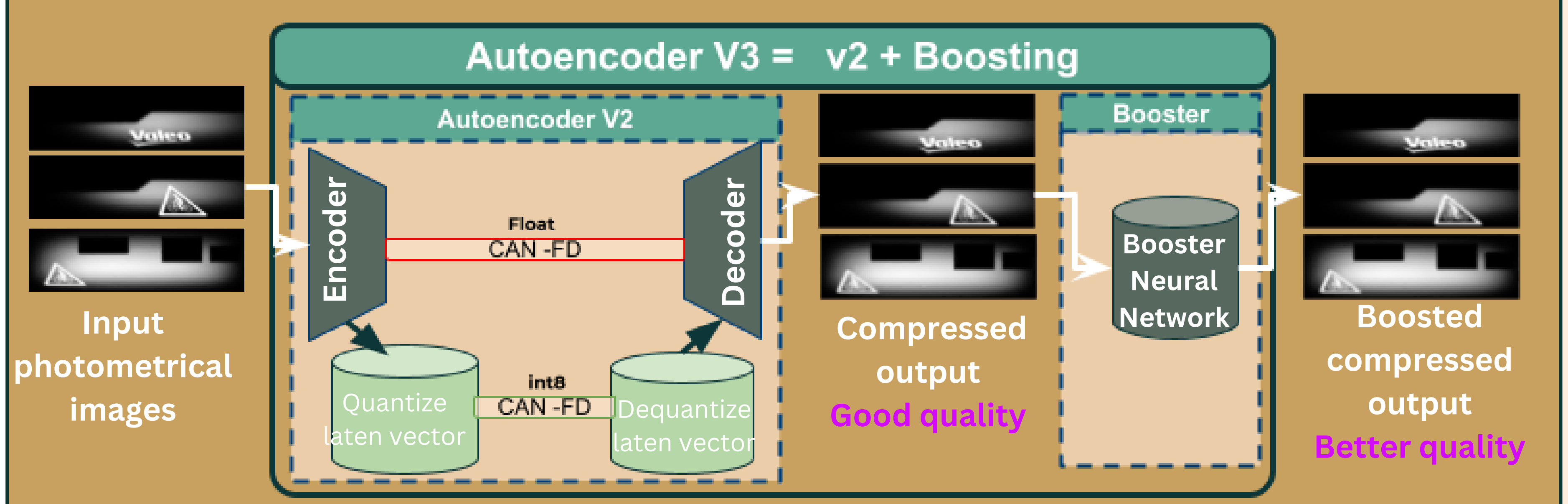
Encoder that compresses the input images, a bottleneck that contains the compressed representation, and a decoder that reconstructs the original images from the compressed representation

Quantization V2

Reducing the number of bits used to represent the compressed images, which can further improve the efficiency of data transmission.

Boosting V3

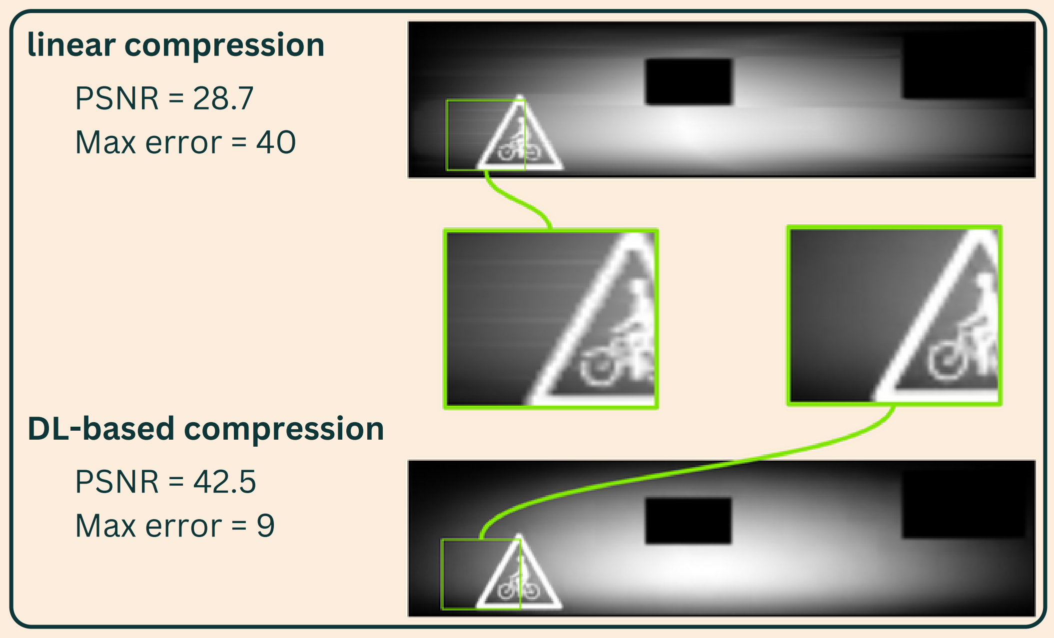
Adding a second autoencoder architecture to alleviate the drawbacks of compression and artifacts.



Deep learning compression Model

Linear compression vs DL compression

The boosting step allows a better quality with less artefacts than reference algoritgms



References

A. Gazdag, L. Buttyan and Z. Szalay, "Efficient lossless compression of CAN traffic logs,"

S. Chen, S. Ranjan, and A. Nucci, “IPzip: a stream-aware ip compression algorithm,”

A. Beirami and F. Fekri, "Network Traffic Compression With Side Information," in IEEE Access.

Contact information

Yasser ALMEHIO: yasser.almehio@valeo.com
Aymane HANINE: aymane.hanine@centrale-casablanca.ma

4 - Results

Results show that DL autoencoders are able to achieve a high level of image quality **(average PSNR 38)** while also achieving a high **compression ratio (96%).**

Autoencoder V1		Autoencoder V2		Autoencoder V3	
CR	PSNR	CR	PSNR	CR	PSNR
52%	30.9	88%	30.9	88%	32.9
84%	36.3	96%	36.4	96%	38.0
92%	32.0	98%	32.0	98%	34.6

$$CR = \frac{Nbr\ of\ bits_{image} \times image\ size - Nbr\ of\ bits_{Latent\ Vector} \times Latent\ Dimension}{Nbr\ of\ bits_{image} \times image\ size}$$

$$PSNR = 10.log_{10}\left(\frac{MAX_I^2}{MSE}\right)$$