Project Title: Enhancing ADAS Object Detection through ISP Pipeline Optimization using Deep Learning

Abstract:

This master dissertation explores Deep Learning-based approaches to automate ISP tuning for automotive cameras, aiming to improve vision-based functionalities in AD/ADAS systems. The methodology involves using Deep Learning for RAW image processing to learn ISP parameters and benchmarking the performance of a Deep Learning-based vision algorithm.

Extended Abstract:

As the market for Autonomous Driving and Advanced Driving Assistance Systems (AD/ADAS) continues to evolve, the demand for improving the performance of vision-based functionalities has become increasingly crucial in terms of accuracy, reliability, safety, and resource consumption. Deep Learning-based approaches have shown a great potential to achieve these goals by replacing traditional procedures based on human expertise.

This thesis aims to explore and implement a Deep Learning-based methodologies to automate the ISP tuning process for automotive cameras. Specifically, we propose to benchmark the performance of a Deep Learning-based vision algorithm that has been trained for a specific task using as input images that were processed by an ISP optimized for human vision, and investigate how it can improve the performance of the algorithm when in this one we introduce as input images that have been processed by an optimized ISP using the Deep Learning-based algorithm implemented in this master dissertation.

Our main methodology involves using Deep Learning techniques for RAW image processing to learn the ISP parameters, and use the output processed image to perform the inference in an already trained Deep Learning-based algorithm without modifying its weights. If there is enough time, we will also consider joint learning of ISP and Computer Vision Benchmarked Algorithm.

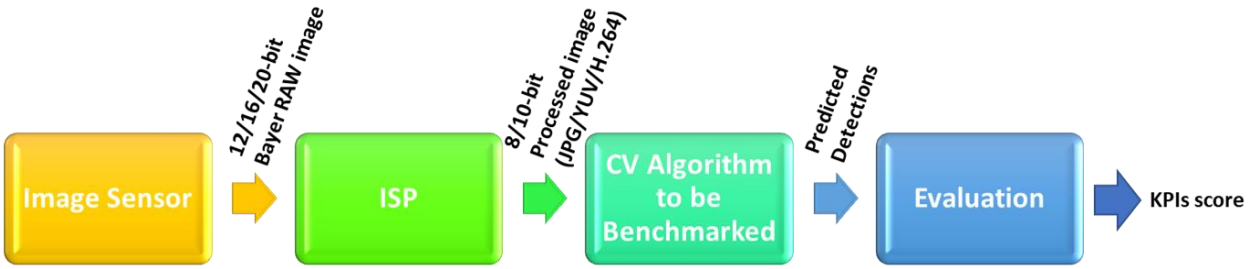

Figure 1: General Schematic of the pipeline before implementing the algorithm proposed in this thesis. The Deep Learning-based algorithm have to control the ISP parameters giving the optimal processed image that yields the highest KPIs score.

Overall, this thesis aims to contribute to the research on Deep Learning-based approaches for ISP tuning in autonomous driving, and to showcase the potential of these methods to improve the performance of vision-based algorithms in AD/ADAS.

The general approach to be followed is:

- A thorough review of the current state of the art literature, challenges, conferences, and image sensor/ISP suppliers' technologies.
- The selection of the setup, dataset, and evaluation metrics. The following datasets are considered:
    - PascalRAW.
    - Synthetic dataset.
    - Company-based data acquisition options, such as RAW+RGB simultaneous data logging using the Automotive Camera Mirror System or Rear-View Camera System.
- The selection of a specific vision-based functionality, among the available options within the company, to be benchmarked.
- The selection of the Deep Neural Network for both methodology and/or model deployment on chip (pre-training, fine tuning…).
- Evaluation of the proposed approach to determine its effectiveness in improving specific vision algorithm KPIs.

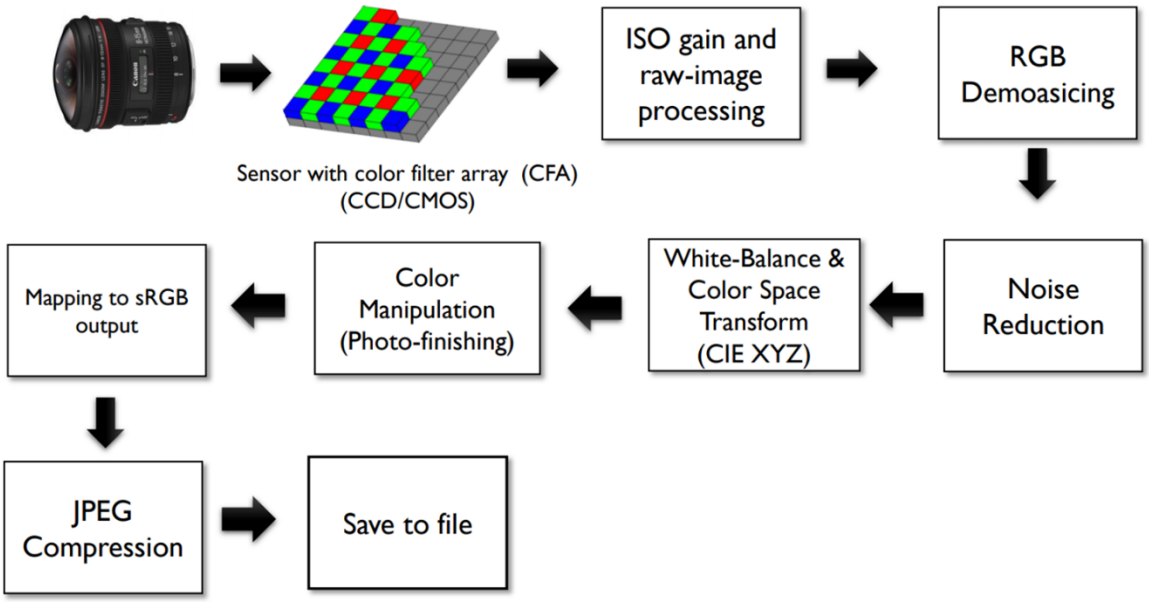

Figure 2: ISP Pipeline example. Source: https://lguduy.github.io/img/post-bg/image-20210123145757648.png

Company supervisors contact:

- Miguel Humberto Rib Perez (miguel.rib@ficosa.com).
- Cristina Perez Benito (c.perez.benito@ficosa.com).