

# Colors make all the difference

Run-time HDR ISP processing enables datalogging of color videos for neural networks training and closed-loop HIL with camera emulation

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Video cameras have gradually evolved, from humble beginnings in rear-view applications into smart sensors that detect objects on the road and improve safety with driving assistance such as automatic braking and lane keeping. Recent ADAS/AD developments have promoted cameras as indispensable for vehicle surroundings perception. While lidar and radar reliably detect road obstacles within the sensor fusion that provides maximum day and night information in all weather conditions, only video cameras can actually recognize and classify objects around the vehicle.

While traditional computer vision systems rely on a luminance video component to recognize shapes, and to some extent on basic chroma components, e.g. traffic signs recognition, modern vision systems based on machine learning and deep neural networks (DNNs) often require full colors in order to understand the world. Colors make all the difference and enable neural networks to better mimic the human brain.

DNNs must be trained to work with maximum reliability in specific ADAS/AD applications. The training runs on powerful servers that use reference input sets with precisely annotated objects.

Trained parameters are used in DNN implementations on the GPU, FPGA or vision processor part of a SoC chip in the ECU controller. Full color videos from the same video sensor and lens, captured from the planned camera's position, ensure the best-possible training and the most reliable DNNs. Yet the process of gathering such videos is more difficult than it might seem at first glance.

Vehicle cameras do not generate colors. They generate an image with color information coded in one of the many Bayer encoding variations.



Also, commonly used high dynamic range (HDR) cameras generate two or three frames taken with different exposures, which, combined in a single frame, equally reveal objects highlighted by direct sunlight and objects placed in extreme shade.

## Pipeline issue

Generation of high-contrast color video requires processing through a dedicated hardware called the HDR image signal processing (ISP) pipeline. HDR ISP pipelines are usually implemented with DNNs in the same SoC chip, which makes the processed color video at DNNs' inputs hardly available for annotation and machine learning outside of the chip. This problem can be solved by datalogging of the processed color video. Since ISP pipelines perform numerous pixel operations on big data, such processing requires a dedicated hardware upgrade to standard dataloggers.

Xylon's logiRECORDER Automotive HIL Video Logger is a perfect platform for such upgrades. It is based on programmable FPGAs and enables HDR ISP integration at the chip level. This ensures the integrity of processed videos and full sensor fusion support through a parallel recording of data from other vehicle sensors.

Xylon has more than 25 years of experience in designing programmable chips, and its logicBRICKS library includes IP cores for ISP processing in programmable FPGA and SoC chips. It enables Xylon to implement the HDR ISP directly in the

**Xylon's logiRECORDER Automotive HIL Video Logger can include an HDR ISP hardware block for run-time processing of raw and monochromatic video inputs from standard automotive cameras, and can record a full-color video processed in formats expected by trained neural networks in the latest-generation computer vision ADAS/AD systems**

datalogger's video I/O module, process raw video on the fly and record color video.

Minor differences between videos processed by Xylon's ISP and the ISP from ECU SoCs have proved tolerable. Xylon works with clients on ISP tuning for specific cameras and achieving optimal video quality for DNN training.

Besides the logging, the logiRECORDER's unique playback capabilities enable HIL with direct injection of recorded data into connected ECUs. The programmable HDR ISP block integrated in the logiRECORDER's video outputs enables quite realistic camera emulation. Instead of blindly playing back the recorded data, the logiRECORDER's HDR ISP block run time modifies the video in response to the ECU's commands. This closed-loop HIL with an ECU that runs production firmware significantly increases assurance of the final product's quality.

The presented solution has been prototyped with several Xylon customers; a production-ready solution is scheduled for Q3 2022. <

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