CASE STUDY

Intel® AI: In Production
Cities and Transportation

Algolux Drives AI Vision in Harsh Settings with OpenVINO™ Toolkit

Algolux Ion Platform* empowers cameras to see more clearly and perceive with accuracy in harsh environments using the Intel® Distribution of OpenVINO™ toolkit

algolux

OpenVINO™

At a Glance

With the Algolux Ion Platform*, computer vision solutions can improve perception accuracy and detection in extreme scenarios such as low-light conditions and bad weather.

- Best-in-class detection and robustness even in extreme scenarios
- No need to acquire or annotate datasets for specific target cameras
- Lower cost and power by removing or reducing components

"Delivering extremely robust perception across different Intel processing platforms allows customers to address numerous market applications. Our collaboration with Intel leverages the OpenVINO™ toolkit to provide a more scalable approach for development and deployment of perception systems using Algolux Eos for vision-critical applications."*

- Dave Tokic,
VP of Marketing and Strategic Partnerships, Algolux

Harsh environments, such as those in low light, bad weather or dusty environments, require unique machine vision systems that address accuracy and performance degradations typically faced by common vision systems. Extreme temperatures, shock and vibration, and dust and water particulates exposure can even damage imaging systems.

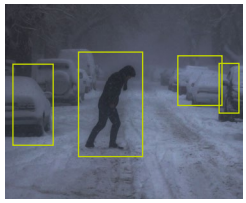
Whether it's for public safety or automotive purposes, cameras need to have an accurate view of the world in any condition to provide AI at the edge solutions. Algolux utilizes the Intel® Distribution of OpenVINO™ toolkit to improve detection accuracy with Eos Perception Software* and Atlas Camera Tuning Suite*, components of the Algolux Ion Platform* for Autonomous Vision. In even the harshest of scenarios, Algolux Eos Perception Software* delivers improvements in perception accuracy of more than 30% as compared to today's most accurate vision algorithms. Algolux introduces machine vision components that can withstand the rigors of harsh environments faced by various industries, including Advanced Driver-Assistance Systems (ADAS), autonomous vehicles, autonomous robots, and public safety.

Challenge

One of the most critical issues in computer vision is the effect of darkness and adverse weather conditions on the performance of vision systems, such as those used for in automotive ADAS, autonomous vehicles, and public safety. Detection scenarios in low light or in snow, fog, and hail conditions negatively impact sensors and cause significant degradation to vision system effectiveness, leading to wrong decisions, car crashes, and the majority of pedestrian deaths.

Solution

The Algolux Ion Platform* for Autonomous Vision uses an innovative deep learning approach—Eos* Deep Learning Technology—to directly address these vision-critical safety challenges, accelerate the design process, and reduce system costs. The software integrates data from several sensors with single or multiple camera perception as well as end-to-end perception to train computer vision models with improved perception accuracy. It enables more optimal architectures, which simplifies the design process, reduces system costs, and provides a path to fully end-to-end learned systems.



30% more accurate perception in harsh environments

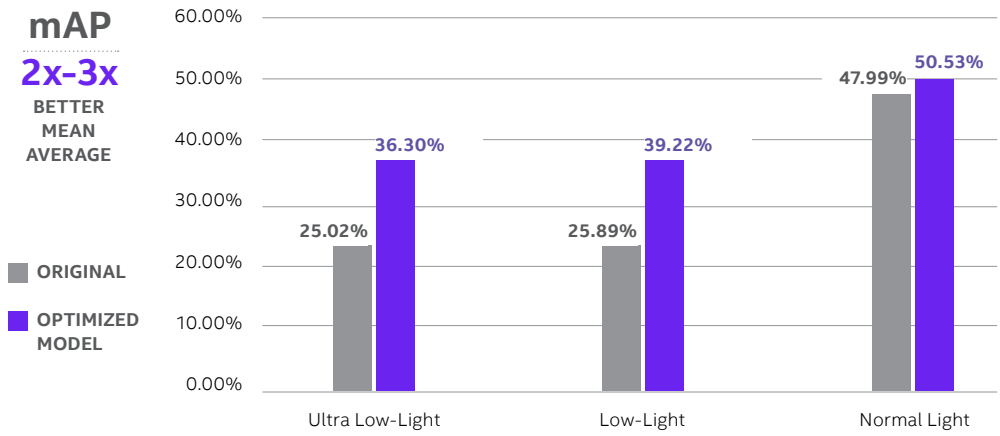
Results

A standard public safety dataset with a large number and variety of subjects was captured in different outdoor and indoor scenes in the Montreal downtown and surrounding areas. Public safety and public datasets, as well as a subset of the captured dataset, were used to train the Eos Perception Software* for seven object categories (bicycle, bus, car, motorbike, person, truck, and van). For runtime evaluation, the model leveraged the Intel® Distribution of OpenVINO™ toolkit implementation flow that delivered labeled bounding boxes as output.

Eos Perception Software* was evaluated against a best-in-class commercially available detector that was similarly trained. Eos* delivered an impressive **2x–3x** better mean Average Precision (mAP @0.5 IOU) accuracy for a broad set of low-light scenarios. (See Figure 1)

Figure 1 | Eos Perception Software* Accuracy in Low-Light Scenarios

The improvement in mean Average Precision (mAP @0.5 IOU) accuracy between the baseline model and the Eos model for each vehicle type from a set of low-light scenarios.



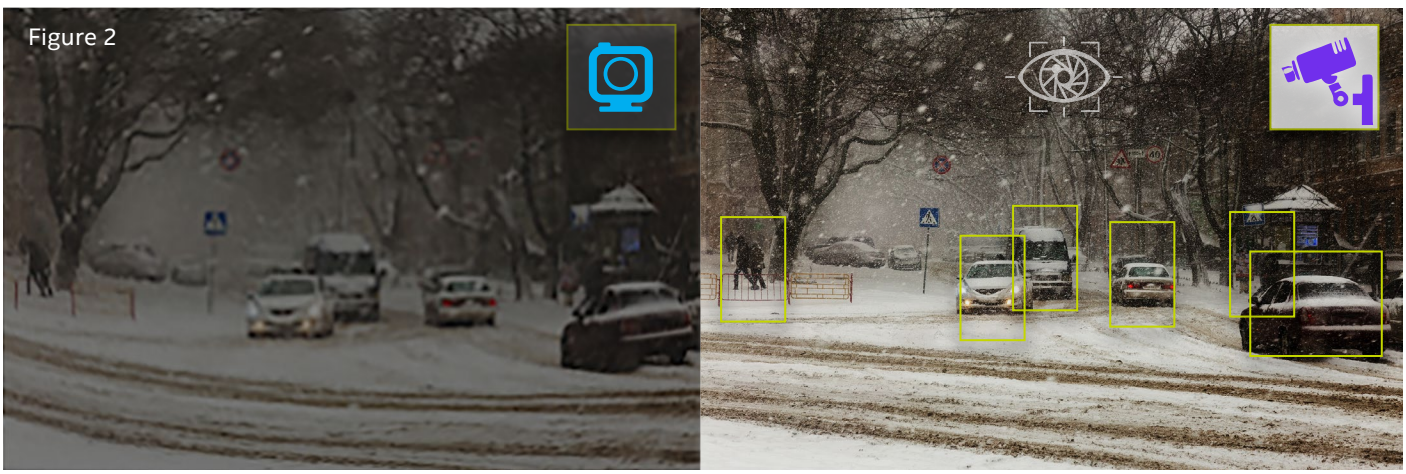
Capturing a Clearer Image

Traditional approaches to computer vision solutions for harsh conditions include the use of disposable imaging cameras, which result in poor image quality and preclude the use of high-performance computing because of higher costs. Another common approach is the use of custom-built enclosures that physically protect the system; however, enclosures increase the size of the complete system, making it nonviable for space-constrained equipment.

Enclosures also tend to degrade optical performance as they deform and warp the image, introduce unwanted light reflections, and create other illumination problems.

Algolux collaborated closely with Intel to apply Eos Perception Software* to use cases—such as pedestrian and public safety, ADAS, and autonomous vehicles—that face low-light or harsh weather conditions to create a new software-based approach. (See Figure 2)

Figure 2



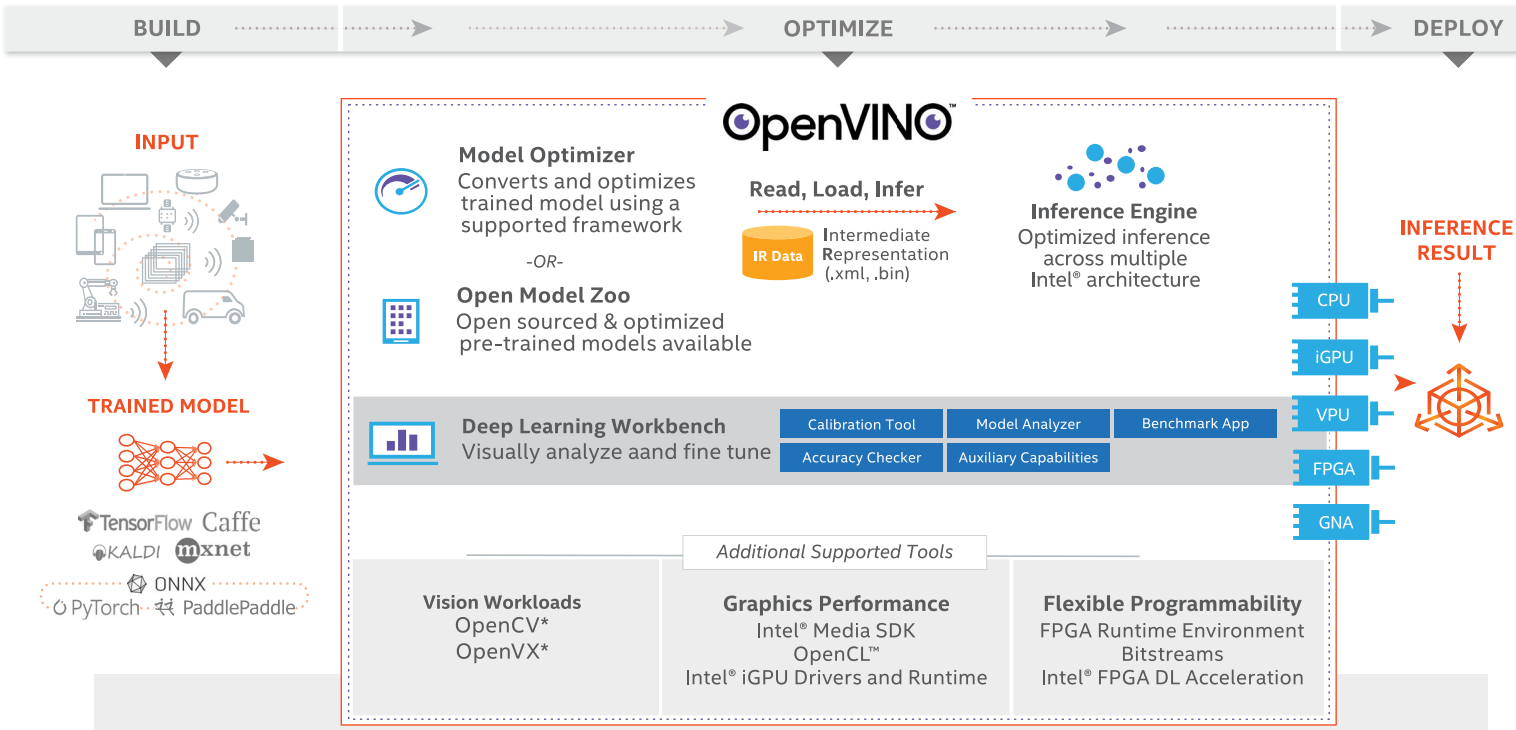
A New Solution for Autonomous Vision

The software is part of the Algolux Ion Platform* for Autonomous Vision, which not only includes Eos Perception Software* but also the Atlas Camera Tuning Suite*. Eos Perception Software* is comprised of single camera perception, multi-camera perception, multi-sensor fusion, and end-to-end perception to deliver industry-best perception accuracy. The camera system used a Sony* IMX249 sensor with a high-quality machine-vision lens CF12.5HA-1 lens, with Eos* taking RAW sensor image directly as input. The Atlas Camera Tuning Suite* is comprised of objective image quality, HDR/AWB, natural image quality, and computer vision to deliver optimized camera architectures. Overall, the Algolux Ion Platform* is a complete, end-to-end vision system design.

Eos Perception Software* is optimized with the Intel® Distribution of OpenVINO™ toolkit, a free software kit that helps developers and data scientists speed up deep learning workloads and streamline deployments from the network edge to the cloud. Combined with the Intel Distribution of OpenVINO toolkit, Eos Perception Software* delivers high-accuracy, production-ready computer vision using existing, clean datasets. The software includes a toolkit for training a model by only using clean data, porting, and pre-trained reference models. With Eos*, there is no need to acquire and annotate datasets for the specific target camera. It also streamlines inference by abstracting users from the need to train, tailor to specific imaging systems, and port to target hardware. Eos* provides robustness even in extreme scenarios. (See Figure 3)

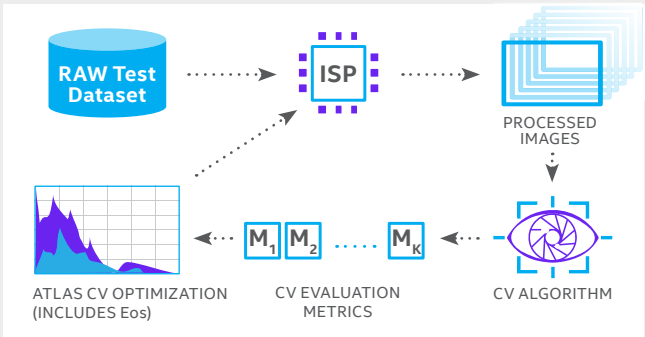
Figure 3 | Under the Hood of Intel Distribution of OpenVINO toolkit

The Intel Distribution of OpenVINO toolkit is a free software kit that helps developers and data scientists speed up computer vision workloads and streamline deep learning deployments from the network edge to the cloud.



Atlas*, also optimized with the Intel® Distribution of OpenVINO™ toolkit, boosts computer vision accuracy by tuning Intel® architecture for the target imaging system. It includes the Atlas* engine and SDK for integrating engine and metrics. It also streamlines development by adding code samples and images. Atlas* automatically determines the optimal Image Signal Processor (ISP) parameters for maximum detection performance, eliminates the dependency on visual tuning, and supports various metrics—including mean Average Precision (mAP) and Panoptic Quality (PQ). (See Figure 4)

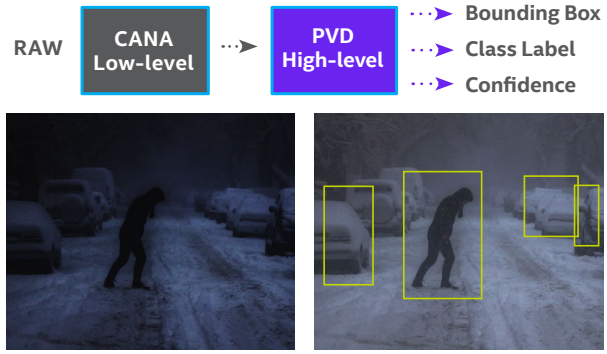
Figure 4 | Combined CANA and PVD Models



Delivering Object Detection in the Worst Conditions

Intel and Algolux collaborated in delivering best-in-class object detection in adverse imaging conditions by integrating the Camera-Aware Neural Network (CANA) model optimized by Algolux's solution with Intel's Person and Vehicle Detection (PVD) available from the Open Model Zoo within the Intel® Distribution of OpenVINO™ toolkit. Algolux's CANA is an end-to-end model composed of a low-level model optimized to deal with low-light and noisy images, and a high-level, task-specific model. Specifically, Intel and Algolux combined the low-level, image-specific components of the CANA model with the high-level components of Intel's PVD model in order to evaluate the joint model's performance in adverse imaging conditions on a previously unseen dataset. The two components were trained jointly to improve the robustness of the high-level task model under low-light, noise, and in general, adverse imaging conditions. (See Figure 5)

Figure 5 | Combined CANA and PVD Models



Algolux and Intel combined a low-level CANA model with a Person and Vehicle Detection (PVD) model to identify objects by class using a bounding box with improved robustness as a high-level task model.

Seven commonly-used object categories—bicycle, bus, car, motorbike, person, van, and truck—were utilized. The base dataset consisted of three public safety datasets (Public Safety 2016 China, Public Safety 2016 US, and Public Safety 2018 China), and three publicly available datasets: COCO, Pascal VOC, and Mapillary. In total, 31,998 frames were captured and 19,499 of them were annotated in four batches.

It was proven that the CANA and PVD model integration can be done without the need for an ISP. Specifically, the CANA and PVD model integration provided a step-function improvement when using the Intel® Neural Compute Stick 2. It also outperformed the original PVD model by **46.72% to 13.09%**—depending on category—despite being trained on unseen data. The performance improved significantly as lighting conditions deteriorated, such as in harsh conditions with low light or bad weather. (See Figure 6)

mAP

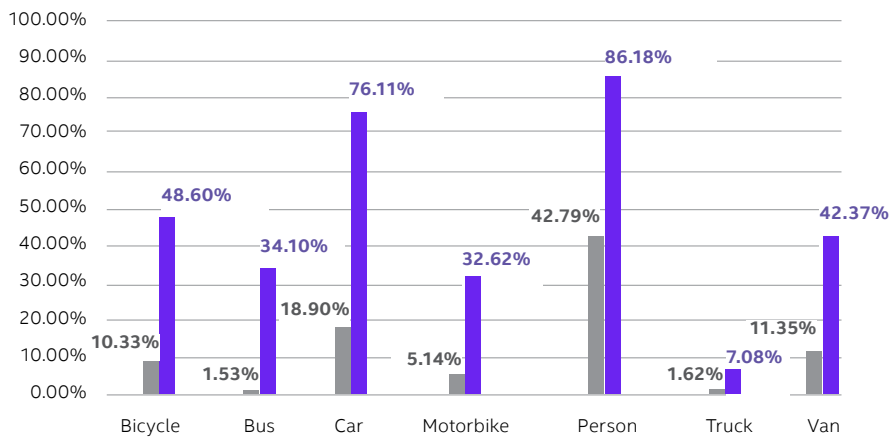
OUTPERFORMED THE ORIGINAL PVD MODEL BY

46.72%
TO
13.09%

ORIGINAL

OPTIMIZED MODEL

Figure 6 | CANA-PVD Performance Versus Base PVD Model



Public safety and public datasets, as well as a subset of the captured dataset, were used to train the Eos Perception Software* for seven object categories (bicycle, bus, car, motorbike, person, truck, and van).

Conclusion

Algolux delivers a robust and scalable perception technology for vision-critical applications including autonomous vehicles. The Algolux Ion Platform* for Autonomous Vision empowers cameras to see clearer and perceive with more accuracy in lowlight. This optimization uses the Intel® Distribution of OpenVINO™ toolkit deployed across Intel® architecture featuring added acceleration powered by the Intel® Neural Compute Stick 2.

Solution Ingredients

- Intel® Distribution of OpenVINO™ toolkit
- Intel® Neural Compute Stick 2 (NCS2)

Learn More

- Intel® AI Technologies
- Intel® Distribution of OpenVINO™ toolkit
- Intel® Neural Compute Stick 2 (NCS2)
- Intel® AI: In Production

Spotlight on Algolux

Algolux's Eos Perception* Software and Atlas Camera Tuning Suite* deliver the most robust and scalable perception technology for vision-critical applications. Through the Intel® AI: In Production ecosystem and the Intel® Distribution of OpenVINO™ Toolkit, Algolux was able to scale and accelerate the path to production for the IoT community.

For more information on Algolux, visit algolux.com.

About Intel® AI: In Production

Intel® AI: In Production is an ecosystem focused on reducing deployment complexities, promoting partner AI offerings, and increasing collaboration between its partners.

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About Algolux

Algolux was founded on groundbreaking deep learning research, computer vision, and computational imaging. Their team of world-class researchers is working to improve AI accuracy and perception, a mission-critical issue for safe ADAS and autonomous vehicles.

An Intel® AI: In Production partner, Algolux is a globally recognized computer vision leader focused on autonomous vehicles. The company's technology delivers autonomous vision with robust and scalable perception technology for vision-critical applications.

For more information on Algolux, visit algolux.com.

Find the solution that is right for your organization
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[1]S. Zang, M. Ding, D. Smith, P. Tyler, T. Rakotoarivelo, and M. A. Kaafar, "The Impact of Adverse Weather Conditions on Autonomous Vehicles: How Rain, Snow, Fog, and Hail Affect the Performance of a Self-Driving Car," IEEE Vehicular Technology Magazine 14, no. 2 (June 2019): 103-111.

[2]AAA, Inc., "Automatic Emergency Braking with Pedestrian Detection," (Oct 2019). https://www.aaa.com/AAA/common/aar/files/Research-Report-Pedestrian-Detection.pdf