The New OpenCV 5: Added Features, Performance Improvements and Future Directions

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OpenCV

What Problems is OpenCV 5 Solving?

1. Better language support
2. Faster & smaller core
3. New Hardware Acceleration Layer (HAL)
4. Cleaner API
5. Deep Neural Network (DNN) engine
6. Better 3D vision support
7. Better documentation

OpenCV 5: Language Support

C/C++

C-API has been deprecated

C++17 is now the minimum recommended standard for C++ compilers

Support for C++20 modules may come in later 5.x versions

OpenCV 5: Enhanced Python Support

Python 2 support deprecated (since 4.3)

Support for Numpy 2.x and deeper integration

Python bindings will remain up-to-date via continuous integration

Plans for "named parameters" in C++ algorithms

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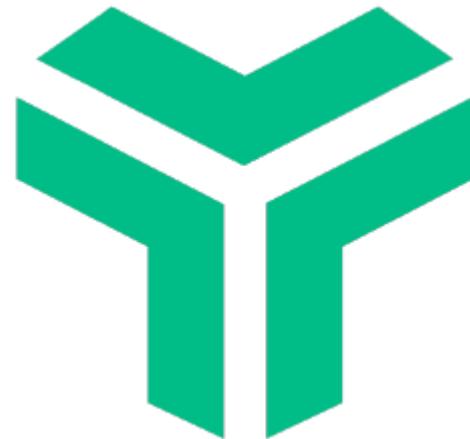7. Better documentation

OpenCV 5: Shiny New Core! But Why?

Core module (2009) formed the fundamental base

Python Array API standard (while still evolving) codifies some of these standards

OpenCV core to align with this standard (making it more numpy-like)

OpenCV 5: Benefits of the New Core

Performance Improvement
- 2x improvements on mathematical workloads because of new data types

Transparent Acceleration
- Same code will run on CPUs and different accelerators without modification

Ease of Use & Flexibility
- New features like broadcasting will improve programmer happiness

Improved Maintainability
- Prevents code duplication by moving important functionality to core

Future-Proof & Community Alignment
- Aligning API with Python Array API standard ensures we are in step with the community

OpenCV 5 Universal Intrinsics

FP16/BF16 Intrinsics Support
CV_SIMD_16F and CV_SIMD_SCALABLE_16F

Template-Based Intrinsics for Simplified Implementation
E.g. vx_setzero<uint8_t>() instead of vx_setzero_u8()

Expanded Mathematical Intrinsics
v_exp(), v_log(), v_sin(), v_cos(), v_tanh(), v_atan2(), v_pow(),
v_erf(), and v_sigmoid()

# Universal Intrinsics in OpenCV 5

1D/2D Interpolation Enhancements

SIMD intrinsics for image resizing, warping, and remapping

ARM NEON optimizations show a 3-4x speed improvement over existing implementations

Future-Proof SIMD Evolution

Universal Intrinsics API is evolving

Long-term SIMD support for both existing and future architectures

ARM NEON optimizations
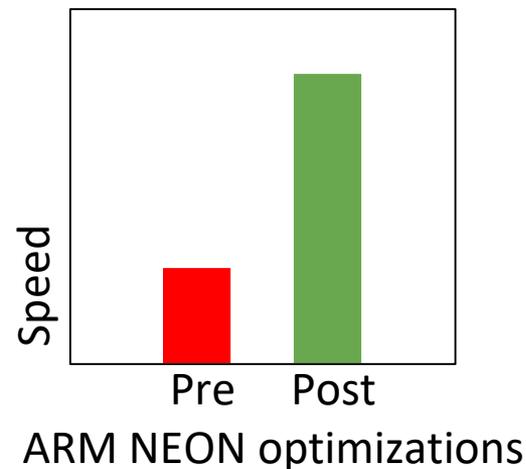
OpenCV 5: Goals Shiny New ImgProc

Feature	Status	Notes
Enable batch processing	5.x	Design discussed, not implemented
Smarter parallelism in filters/transforms	5.0 (partial)	Case-by-case optimizations (e.g., warpAffine multi-threaded)
FP16/BF16 support in Imgproc	5.0 (partial)	Infrastructure in place, not widespread yet
ONNX-compliant resize	5.0 (partial)	Implemented
TrueType/UTF-8 text rendering	5.0	cv::putText now supports TTF text

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OpenCV 5: New Hardware Abstraction Layer (HAL)

HAL allows hardware-specific accelerated implementation

New CPU HAL but also a non-CPU HAL for accelerators

All the core functions are built to use this HAL

Same core code can run on different backends – e.g., transparently dispatching to GPU, or other accelerators – if available

HARDWARE ABSTRACTION LAYER

CPU GPU NPU
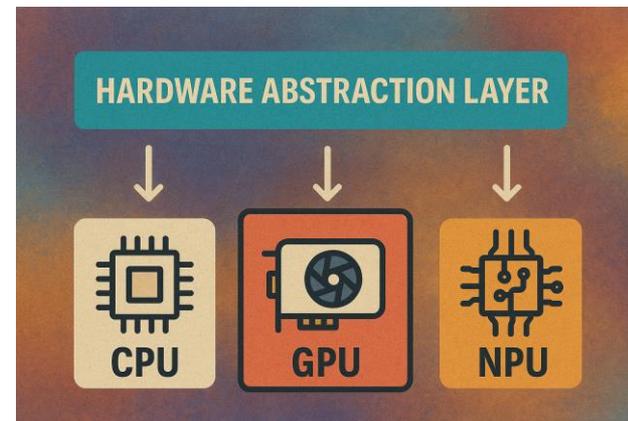
OpenCV

arm
KleidiCV

Qualcomm
FastCV

RISC-V®

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OpenCV 5: API Cleanup

Features Module

- Replaces Features2D
- DNN-based features (part of Google Summer of Code)
- Several obsolete feature detectors/descriptors have been moved to opencv_contrib. SIFT, ORB, FAST, GoodFeaturesToTrack, MSER are still available

Object Detection

- Haar, HOG → opencv_contrib, xobjdetect module (use DL based object detection)

Classic ML module

- Moved to opencv_contrib (or use scikit-learn instead)
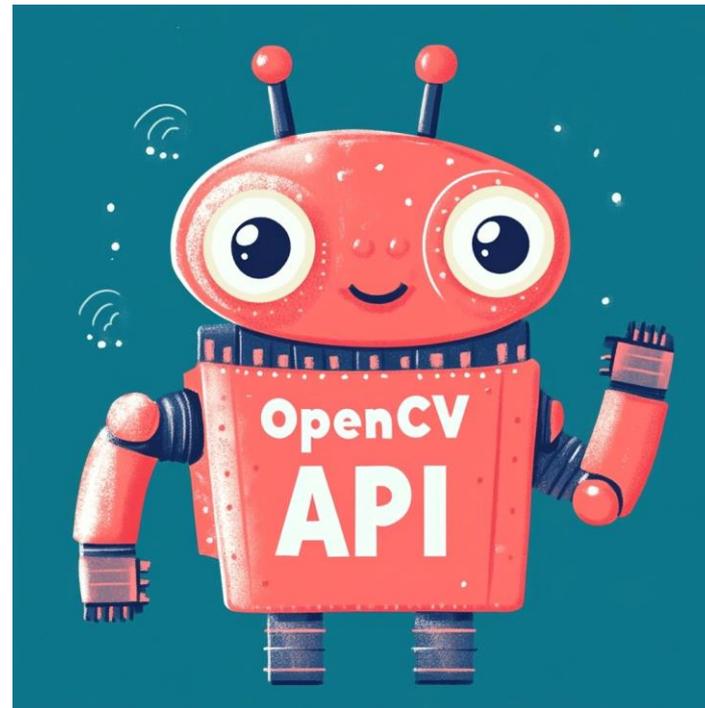
OpenCV 5: API Cleanup
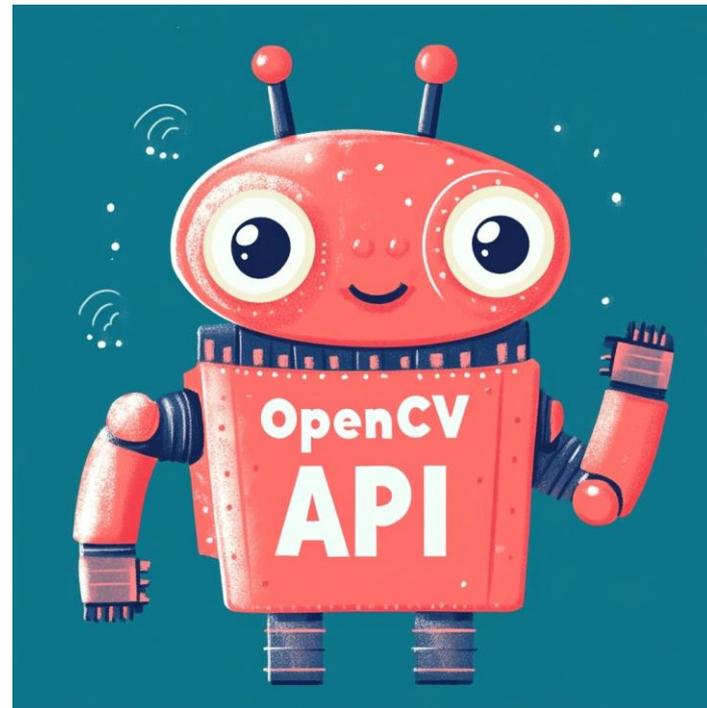
Approximate Nearest Neighbor (ANN)

- Removed FLANN as a separate module
- Annoy-based ANN search algorithm in Features replaced it

Graph API

- Graph API (G-API) module has been moved to opencv_contrib
- Dropped OpenVX support

Photo Module

- Macbeth chart detector & color calibration/correction pipeline moving to main OpenCV

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OpenCV 5: API Cleanup

Calib3d module split into 3 modules:

1. 3d
- Basic 3D geometry
- 3D vision functionality. IO, algos like ICP, parts of SLAM

2. calib
- Camera calibration
- Multi-camera calibration pipeline

3. stereo
- Algorithms for depth map estimation via stereo correspondence

What Problems is OpenCV 5 Solving?

1. Better language support
2. Faster & smaller core
3. New Hardware Acceleration Layer (HAL)
   a. Enables easier hardware acceleration
4. Cleaner API
5. **Deep Neural Network (DNN) engine**
6. Better 3D Vision Support
7. Better Documentation

OpenCV 5: Next-Gen Deep Learning (DNN) Engine

Parsers

- Improved ONNX model parser

- Torch7 (not PyTorch) parser removed

Data Types

- Support for additional data types (E.g., int8/int32 for networks)

- Improving backends (E.g., OpenVINO backend support for integer models and OpenCL acceleration)

OpenCV 5: Next-Gen Deep Learning (DNN) Engine

Diffusion Models Support

https://github.com/opencv/opencv/blob/5.x/samples/dnn/ldm_inpainting.py

OpenCV 5: Next-Gen Deep Learning (DNN) Engine

Better Transformer Support

https://github.com/opencv/opencv/blob/5.x/samples/dnn/gpt2_inference.py

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OpenCV 5: 3D Vision Enhancements

3D visualization support & texture mapping

ChArUco board support for robust multi-marker and multi-camera calibration

3D Gaussian splats and camera relocalization

(Under research)

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OpenCV 5: Better Documentation & Samples

The documentation has been updated and migrated to the latest Doxygen

Many samples have been revised

New samples have been added

Conclusion

1. OpenCV 5 will be ready this summer
2. Major upgrade
   a. Performance improvements across platforms
   b. API cleanups
   c. New functionality
3. Beware of backward compatibility breaks

Resources

1. OpenCV.org website
2. OpenCV GitHub repository
   a. OpenCV 5 branch
3. Documentation
4. **OpenCV membership programs**
   a. Gold
   b. Silver
   c. Bronze
5. OpenCV University

Thank You!