DRIVES

Development and Research on Innovative Vocational Education Skills

COMPUTER VISION IN PRACTICE

U3.E3. RESOLUTION OF COMMON COMPUTER VISION PROBLEMS

Computer Vision Expert

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LEARNING OBJECTIVES

The student is able to

CVE.U3.E3.PC1	Realize the differences between the various state-of-the-art tools studied and select the best tool given a specific situation or problem.
CVE.U3.E3.PC2	Use state-of-the-art tools to develop solutions for computer vision problems.
CVE.U3.E3.PC3	Carefully test and evaluate the solutions developed and make the necessary changes to achieve the best solution possible.

APPLICATIONS SOLVED BY OPENCV

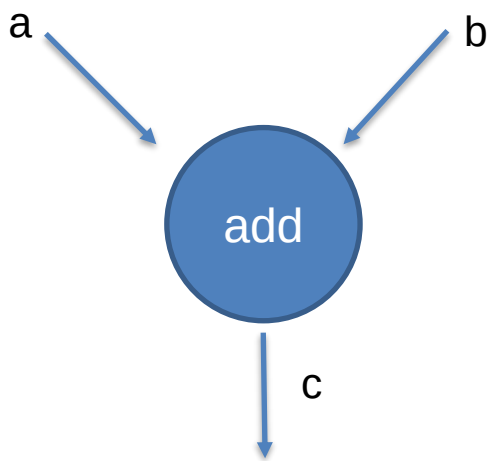
Some of the applications that can be solved using OpenCV are:

- Face recognition
- Automated inspection and surveillance
- Number of people – count (foot traffic in a mall)
- Vehicle counting on highways along with their speeds
- Interactive art installations
- Anamoly (defect) detection in the manufacturing process
- Street view image stitching
- Video/image search and retrieval
- Robot and driver-less car navigation and control
- Object recognition
- Medical image analysis
- Auto Movies – 3D structure from motion
- TV Channels advertisement recognition

TENSOR FLOW

TensorFlow is a software library for numerical computation using **data flow graphs** where:

- **nodes** in the graph represent mathematical operations.
- **edges** in the graph represent the multidimensional data arrays (called **tensors**) communicated between them.



- **add** is a node which represents addition operation. **a** and **b** are input tensors and **c** is the resultant tensor.
- This is a flexible architecture that allows to deploy computation to one or more CPUs or GPUs in a desktop, server, or mobile device with a single API.

MATLAB APPLICATIONS

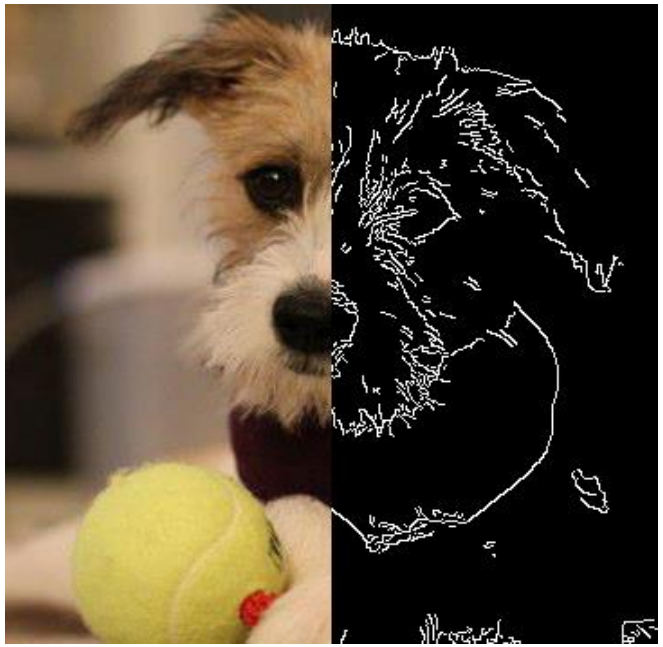
- **Control Systems:** Design, test, and implement control systems;
- **Deep Learning:** Data preparation, design, simulation, and deployment for deep neural networks;
- **Image Processing and Computer Vision:** Acquire, process, and analyze images and video for algorithm development and system design;
- **Machine-learning:** Train models, tune parameters, and deploy to production or the edge;
- **Predictive Maintenance:** Develop and deploy condition monitoring and predictive maintenance software;
- **Robotics:** Convert your robotics ideas and concepts into autonomous systems that work seamlessly in real-world environments.
- **Signal Processing:** Analyze signals and time-series data. Model, design, and simulate signal processing systems;
- **Test and Measurement:** Acquire, analyze, and explore data and automate tests;
- **Wireless Communications:** Create, design, test, and verify wireless communications systems;

MATLAB APPLICATIONS

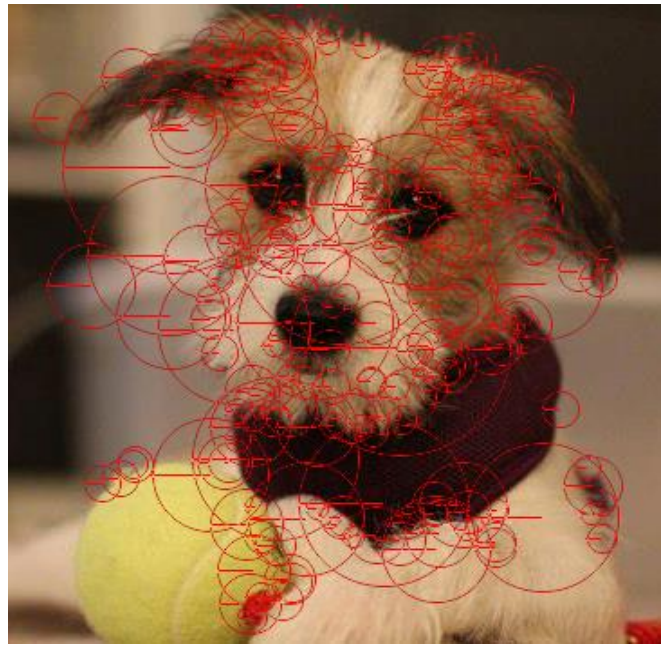
- **Internet of Things:** Connect embedded devices to the Internet and gain insight from your data;
- **Automated Driving Systems:** Design, simulate, and test automated driving systems;
- **Computational Biology:** Analyze, visualize, and model biological data and systems;
- **Data Science:** Explore data; build machine learning models; do predictive analytics;
- **Embedded Systems:** Design, code, and verify embedded systems;
- **Enterprise and IT Systems:** Use MATLAB with your IT systems;
- **FPGA, ASIC, and SoC Development:** Automate your workflow — from algorithm development to hardware design and verification;
- **Mechatronics:** Design, optimize, and verify mechatronic systems;
- **Mixed-Signal Systems:** Analyze, design, and verify analog and mixed-signal systems;
- **Power Electronics Control Design:** Design and implement digital control for motors, power converters, and battery systems;
- **Power Systems Analysis and Design:** Design and simulate electric grids and transportation systems;

SIMPLECV APPLICATIONS

The SimpleCV threshold method sets each pixel in an image to black or white depending on its brightness.



The SimpleCV edge method sets edge pixels in the image to white.



The Image.findKeypoints method is used for a variety of 3D reconstruction and image matching tasks.

CUDA APPLICATIONS

CUDA accelerates applications from domains like image processing, to deep learning, numerical analytics and computational science.

Some applications are:

- Data Science;
- Computational Chemistry;
- Machine Learning;
- BioInformatics;
- Computational Fluid Dynamics;
- Weather and Climate

YOLO APPLICATIONS

YOLO is an algorithm that uses neural networks to provide real-time object detection. It is important because of its **Speed, High accuracy, and Learning capabilities.**

Some applications are:

- Autonomous driving
- Wildlife
- Security

BOOFCV APPLICATIONS

BoofCV comes with various utilities and applications for assisting with computer vision.

Some applications are:

- Print a calibration target
- Create a custom AR marker
- Undistorted many images
- Create QR Codes
- Calibrate your camera.

Depending on Edge Computing

- computer vision solutions will need to be deployed on edge endpoints for most use cases. This enables processing the data where it is captured while only the results are sent back to the cloud for further analysis.

Hardware Limits It

- Computer Vision require hardware to run, cameras to provide the visual input and computing hardware for Artificial Intelligence (AI) inference.

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The Complexity of Scaling Computer Vision Systems

The seven most important drivers of complexity:

- Collecting input data specific to the problem
- Knowledge of popular Deep Learning frameworks like Tensorflow for training and evaluating Deep Learning models
- Choosing the suitable hardware (e.g., Intel, NVIDIA, ARM) and software platforms (e.g., Linux, Windows, Docker, Kubernetes) and optimizing Deep Learning models for the deployment environment
- Managing deployments to distributed Edge devices from the Cloud
- Sorting and rolling out updates across the fleet of Edge endpoints
- Monitoring metrics from all endpoints and data analysis in real-time
- Knowledge about data privacy and security best practices

HOW TO OVERCOME THE COMPLEXITY OF COMPUTER VISION

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- **Visual Programming:** Use a visual approach to build complex computer vision and deep learning solutions on the fly. The visual programming approach can decrease development time by over 90%.
- **Device Management:** Add and manage edge devices and AI hardware easily, independently of the device type and architecture.
- **Deployment Management:** Use an integrated device management tool to enroll and manage endpoint devices.
- **Modular Approach:** Take advantage from pre-existing software modules to build an use case.
- **Flexibility where needed**: Add the algorithms and code where needed for your custom computer vision solution. Only, build the code that does not exist yet.

SUMMARY

- OpenCV and MATLAB are the tools with the most applications.
- YOLO is important because of its **Speed, High accuracy, and Learning capabilities.**
- Computer vision has some problems like Depending on Edge Computing, limited hardware and the Complexity of Scaling computer vision systems.

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Thank you for your attention

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The aim of the Blueprint is **to support an overall sectoral strategy and to develop concrete actions to address short and medium term skills needs.**

Follow DRIVES project at:

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