Introduction to OpenCV

What is OpenCV?

- OpenCV means Intel® Open Source Computer Vision Library.
- It is a collection of C functions and a few C++ classes that implement some popular Image Processing and Computer Vision algorithms.
- The library runs under Linux, Windows and Mac OS X

- OpenCV was designed for computational efficiency and with a strong focus on real-time applications
- OpenCV is written in optimized C and can take advantage of multicore processors

- If you desire further automatic optimization on Intel architectures, you can buy Intel's Integrated Performance Primitives (IPP) libraries, which consist of low-level optimized routines in many different algorithmic areas
- OpenCV automatically uses the appropriate IPP library at runtime if that library is installed

Functions

- One of OpenCV's goals is to provide a simple-to-use computer vision infrastructure that helps people build fairly sophisticated vision application quickly
- The OpenCV library contains over 500 functions

- The functions cover the following areas
  - Factory product inspection
  - Medical imaging
  - Security
  - User interface
  - Camera calibration
  - Stereo vision
  - Robotics

- Because computer vision and machine learning often go hand-in-hand, OpenCV also contains a full, general-purpose Machine Learning Library (MLL)
  - Statistical pattern recognition
  - Clustering

License

- FREE for commercial and non-commercial uses
- The open source license for OpenCV has been structured such that you can build a commercial product using all or part of OpenCV
- You are under no obligation to open source your product or to return improvements to the public domain – but they hope that you will

- Because of these liberal licensing terms, there is large user community
  - Companies: IBM, Microsoft, Intel, SONY, Simens, and Google, etc.
  - Research centers: Stanford, MIT, CMU, Cambridge, and INRIA
  - Yahoo groups forum

https://groups.yahoo.com/neo/groups/OpenCV/info

Applications

- Stitching images together in satellite and web maps
- Image scan alignment
- Medical image noise reduction
- Object analysis
- Security and intrusion detection system
- Automatic monitoring and safety systems
- Manufacturing inspection system

- Camera calibration
- Military applications
- Unmanned aerial, ground and underwater vehicles
- Sound and music recognition, vision recognition techniques are applied to sound spectrogram images
- Vision system in Stanford robot “Stanley”, which won $2M DARPA Grand Challenge desert robot race

- OpenCV is aimed at providing the basic tools needed to solve computer vision problems
  - High-level functionalities in the library will be sufficient to solve the more complex problems
  - The basic components in the library are complete enough to enable creation of a complete solution of your own to almost any computer vision problem

The origin of OpenCV

- OpenCV grew out of an Intel Research
- Enabling computer vision applications would increase the need for fast processors
- Driving upgrades to faster processors would generate more income for Intel than selling some extra software
- In this sense, there is more room to be innovative at software within a hardware company

Goals

- Advance version research by providing not only open but also optimized code for basic vision infrastructure. No more reinventing the wheel
- Disseminate vision knowledge by providing a common infrastructure that developers could build on, so that code would be more readily readable and transferable
- Advance vision-based commercial applications by making portable, performance-optimized code available for free – with a license that did not require commercial applications to be open or free themselves

OpenCV Documentation

- The primary documentation is the HTML documentation that ships with the source code
- Besides, OpenCV's documentation Wiki is more up-to-date than the html pages that ship with OpenCV and it also features additional content as well

https://en.wikipedia.org/wiki/OpenCV

http://opencvlibrary.sourceforge.net/

OpenCV structure and Content

- OpenCV broadly structured into five main components
  1. CV
     - The basic image processing algorithms
     - Higher-level computer vision algorithms
  2. ML (machine learning library)
     - Statistical classifiers
     - Clustering tools

3. High GUI
   - I/O routines
   - Functions for storing and loading video and images
4. CXCore
   - Basic data structures and algebra related operation (matrix operation)
5. CvAuX (in old version)
   - Camera related

Portability

- OpenCV is designed to be portable
- It was originally written to compile across Borland C++, MSVC++, and the Intel compilers
- The C and C++ code had to be fairly standard in order to make cross-platform support easier
- Compatibility between different versions is not so good

Comparison

Matlab	OpenCV
• Integrates computation, visualization and programming in a easy to use environment • Has huge array of provided functions • Great interface for displaying and manipulating data while debugging	• C/C++ library • Open source • Has Windows, Linux and Mac versions • Has basic data structures for matrix operation and image processing

Matlab	OpenCV
• Excellent for math and computation , algorithm development, modeling, simulation and prototyping • Excellent documentation • Very slow while processing images • Hardly use for real time image processing	• Code is highly optimized for image processing • Fast and efficient • Bad documentation • Don’t handle errors • Can be recommended for any complex real time image processing