# Computer Vision

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# Informatii generale

- Pagina web a cursului
  - http://inf.ucv.ro/~cstoean
- Nota
  - Se obtine in urma realizarii unor proiecte.
  - Teme de proiect vor fi enuntate pe parcursul cursului si cuprind:
    - in principal, procesari de imagini
    - dar si extrageri de informatii din imagini (masuratori, calcule etc) folosind sau nu invatare automata
    - fiecare tema are asociat un numar de puncte si are un termen limita.
  - Studentii care nu au realizat (suficiente) proiecte vor da un examen scris.

# Bibliografie 1/2


- Robert Laganière, OpenCV 2 Computer Vision Application Programming Cookbook, Packt Publishing, Birmingham, UK, 2011.
- Gary R. Bradski, Vadim Pisarevsky, Jean-Yves Bouguet, Open Source Computer Vision Library, Springer, 1st ed. 2006.
- Gady Agam, Introduction to programming with OpenCV, Illinois Institute of Technology, 2006, http://www.cs.iit.edu/~agam/cs512/lect-notes/opencv-intro/opencv-intro.html

# Bibliografie 2/2


- D.A. Forsyth, Jean Ponce, Computer Vision - A Modern Approach (2nd Edition), Jean Ponce, 2011.
- Gary Bradski and Adrian Kaehler, Learning OpenCV: Computer Vision with the OpenCV Library, O'Reilly Media, 2008. http://www.cse.iitk.ac.in/users/vision/dipakmj/papers/OReilly%20Learning%20OpenCV.pdf .
- Peter Corke, Robotics, Vision & Control, Springer 2011.

# Continutul cursului

- Computer Vision cu OpenCV
- Încărcarea, afisarea si salvarea imaginilor
  - Crearea unei aplicatii GUI folosind QT pentru procesare de imagini
- Accesarea valorilor pentru pixeli din cadrul unei imagini
- Definirea de regiuni de interes in imagini
- Procesare de imagini cu clase
- Histograma unei imagini
- Detectarea continutului unei imagini folosind histograma
- Transformarea imaginilor cu operatii morfologice
- Extragerea de linii, contururi si componente
- Detectarea de puncte de interes
- Detectarea de obiecte dupa culoare
- Procesarea de secvente video

# Ce este Computer Vision?

- Transformarea datelor de la o camera foto sau video intr-o reprezentare noua sau chiar in decizii.
  - Camera poate fi montata pe o masina
  - Un laser poate indica faptul ca te apropii mai aproape de 1 metru de un obiect
- Aceste observatii se fac in general simplu, intruitiv de catre om.

# Ce este Computer Vision?

- Este banal pentru un om sa identifice o masina intr-o poza
  - S-a focusat in imagine doar pe acea regiune
  - A vazut deja suficiente masini anterior ca sa aiba o reprezentare clara asupra lor

**Dar o masina vede:**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 194 | 210 | 201 | 212 | 199 | 213 | 215 | 195 | 178 | 158 | 182 | 209 |
| 180 | 189 | 190 | 221 | 209 | 205 | 191 | 167 | 147 | 115 | 129 | 163 |
| 114 | 126 | 140 | 188 | 176 | 165 | 152 | 140 | 170 | 106 | 78 | 88 |
| 87 | 103 | 115 | 154 | 143 | 142 | 149 | 153 | 173 | 101 | 57 | 57 |
| 102 | 112 | 106 | 131 | 122 | 138 | 152 | 147 | 128 | 84 | 58 | 66 |
| 94 | 95 | 79 | 104 | 105 | 124 | 129 | 113 | 107 | 87 | 69 | 67 |
| 68 | 71 | 69 | 98 | 89 | 92 | 98 | 95 | 89 | 88 | 76 | 67 |
| 41 | 56 | 68 | 99 | 63 | 45 | 60 | 82 | 58 | 76 | 74 | 65 |
| 20 | 41 | 69 | 75 | 56 | 41 | 51 | 73 | 55 | 70 | 63 | 44 |
| 50 | 50 | 57 | 69 | 75 | 75 | 73 | 74 | 53 | 68 | 59 | 37 |
| 72 | 59 | 53 | 66 | 84 | 92 | 84 | 74 | 57 | 72 | 63 | 42 |
| 67 | 61 | 58 | 65 | 75 | 78 | 76 | 73 | 59 | 75 | 69 | 50 |

# De ce Computer Vision?

- Imagini (si filme) sunt pretutindeni
- Aplicatii utile care sa extraga informatii din imagini:
  - Identificarea automata a numarului de la masina
  - Identificarea feței
  - Identificarea unor regiuni de interes intr-o imagine
  - Procesarea filmelor
- Exista deja multe soft-uri care face astfel de procesari.
  - Dar cand avem nevoie sa procesam zeci, sute sau chiar mii de imagini/filme, este esential sa ne cream propria aplicatie care sa realizeze aceste lucruri.

# OpenCV

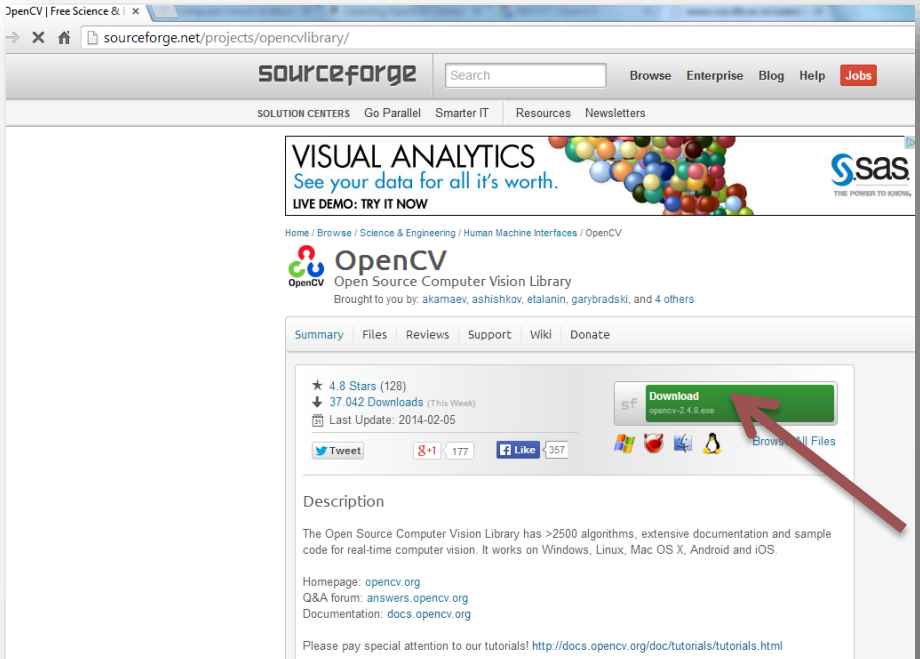
- Reprezinta o librarie gratuita (Open) pentru dezvoltare si cercetarea in Computer Vision
  - http://sourceforge.net/projects/opencvlibrary/
- Contine peste 2500 de algoritmi
- Functioneaza sub Windows, Linux, Android, Mac OS.
- Sunt dezvoltate interfete pentru limbaje precum: C++, C, Java, Python, Matlab.
- Ofera infrastructura pentru Computer Vision pentru a construi rapid aplicatii sofisticate
- Cursul ne va ajuta sa alegem ce algoritm sa utilizam pentru scopul avut si in ce moment

# OpenCV

- Are peste 7 mil de descarcari
- Printre utilizatori se numara si companii mari precum Google, Yahoo, Microsoft, Intel, IBM, Sony etc.
- Printre algoritmii continuti sunt unii dedicati pentru:
  - Recunoasterea feței
  - Identificarea de obiecte
  - Urmarirea obiectelor in miscare
  - Gasirea de imagini similare intr-o baza de date cu imagini
  - Eliminarea ochilor rosii din poze
  - Urmarirea ochilor in miscare
- Functioneaza sub diferite medii de dezvoltare integrate (IDE) pentru C++.

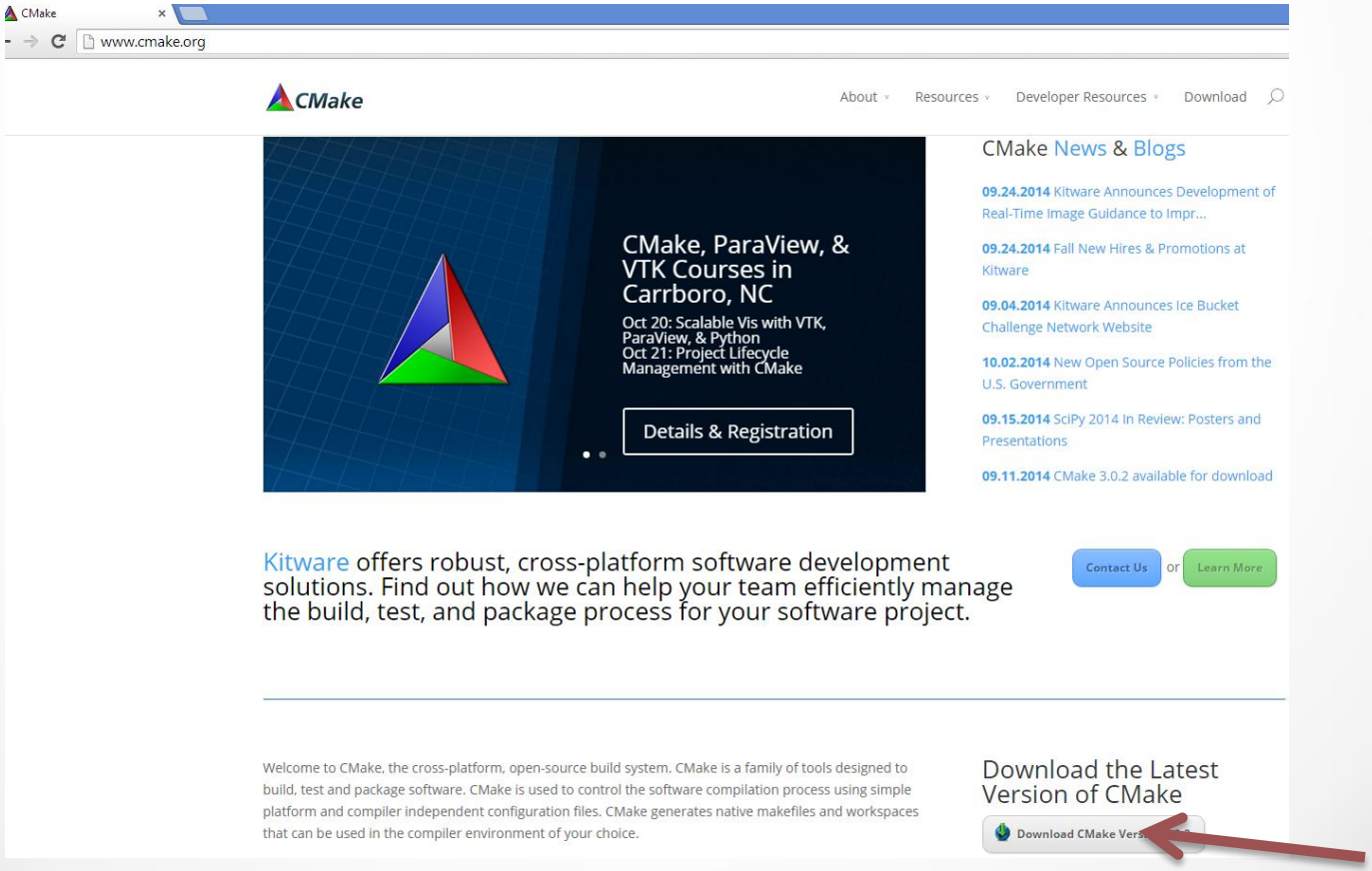
# Descarcarea OpenCV

- **Presupunem instalat deja Visual Studio 2010 (sau 2012, 2013, 2015…)**
  - Gratuit prin contul personal de la DreamSpark http://e5.onthehub.com/d.ashx?s=bc81baqimt
- Cea mai recenta versiune de OpenCV se descarca de la http://sourceforge.net/projects/opencvlibrary/
  - Arhiva se extrage intr-un folder, de exemplu in D:\OpenCV2



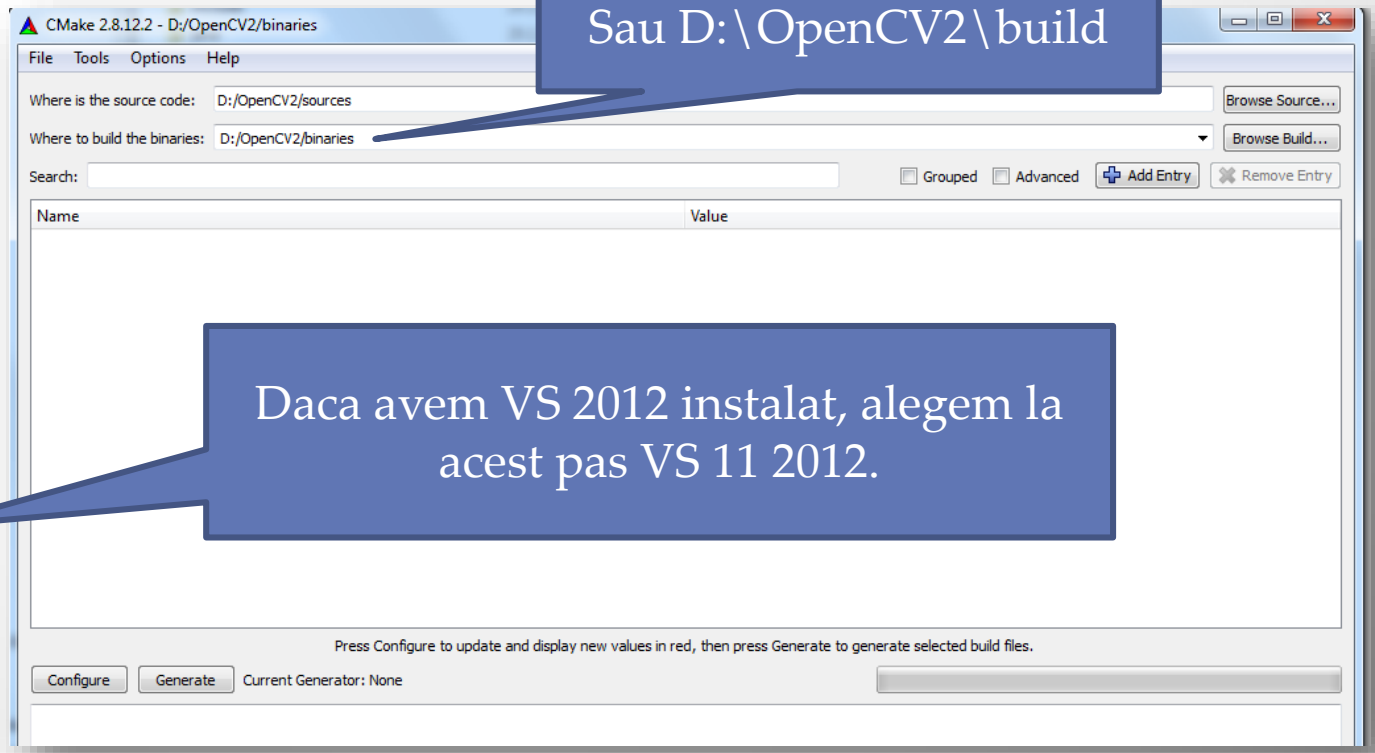
# Instalarea OpenCV

- Dupa descarcare, libraria se instaleaza
- Pentru aceasta, descarcati CMake (open-source)



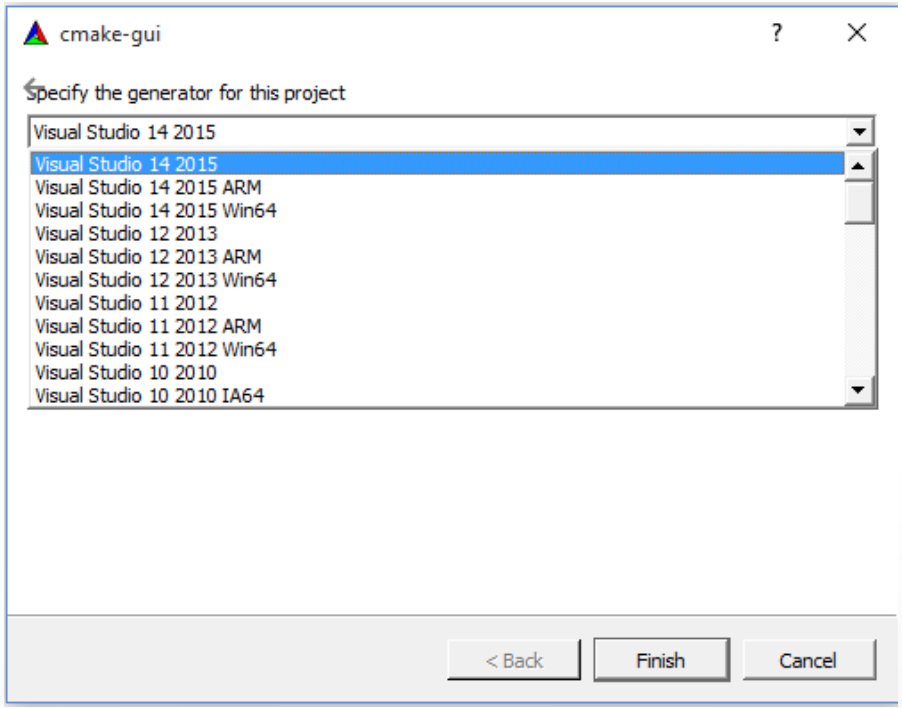
# Instalarea OpenCV

- Dupa descarcare, libraria se instaleaza
- Pentru aceasta, descarcati si instalati CMake (open-source)
- Se pun:
  - Calea catre sursa
  - Calea catre libraria compilata
- Configure
  - Se alege Visual Studio 10
- Generate



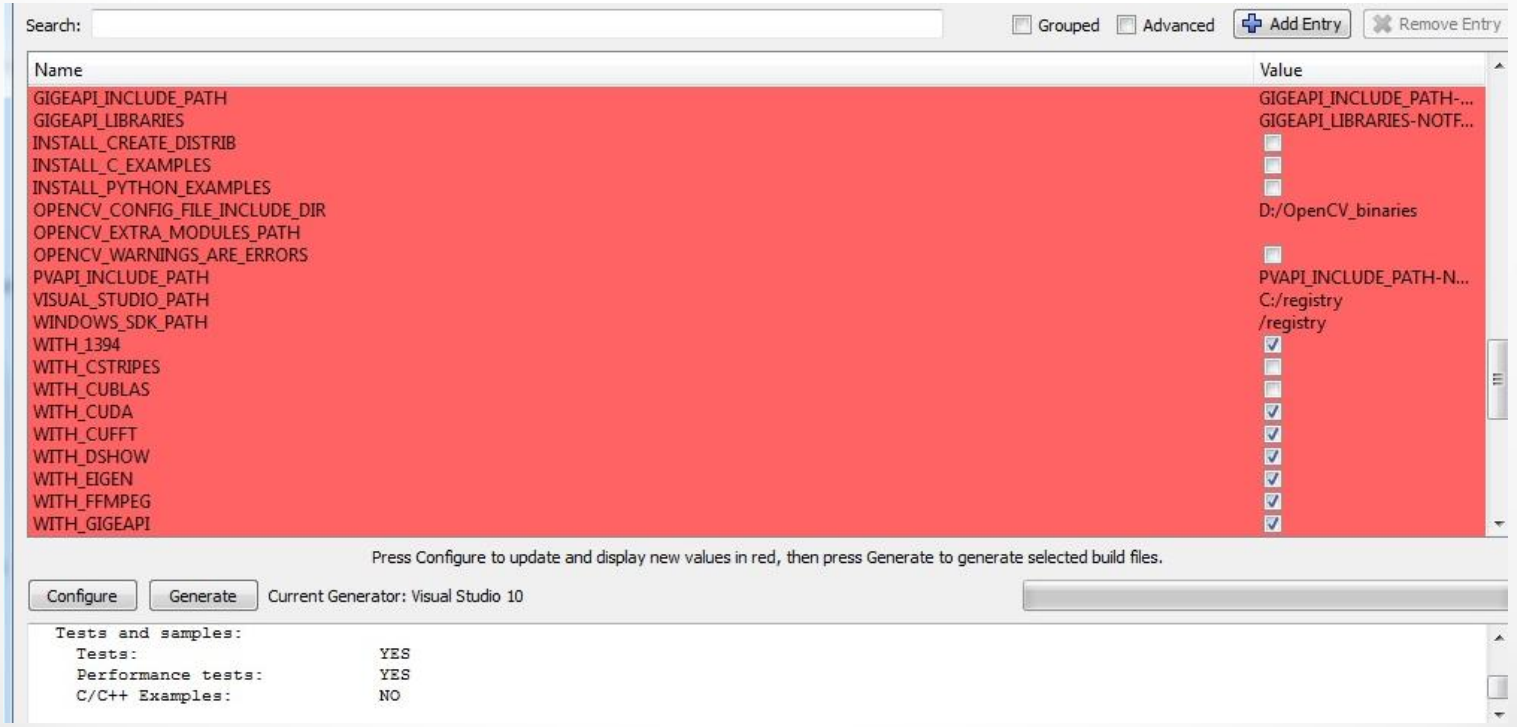
# Alegerea generatorului CMake

- Generatorul se selecteaza in functie de versiunea de Visual Studio pe care o avem si de ce platforma folosim la Configuration Platform (Win 32 sau X64).



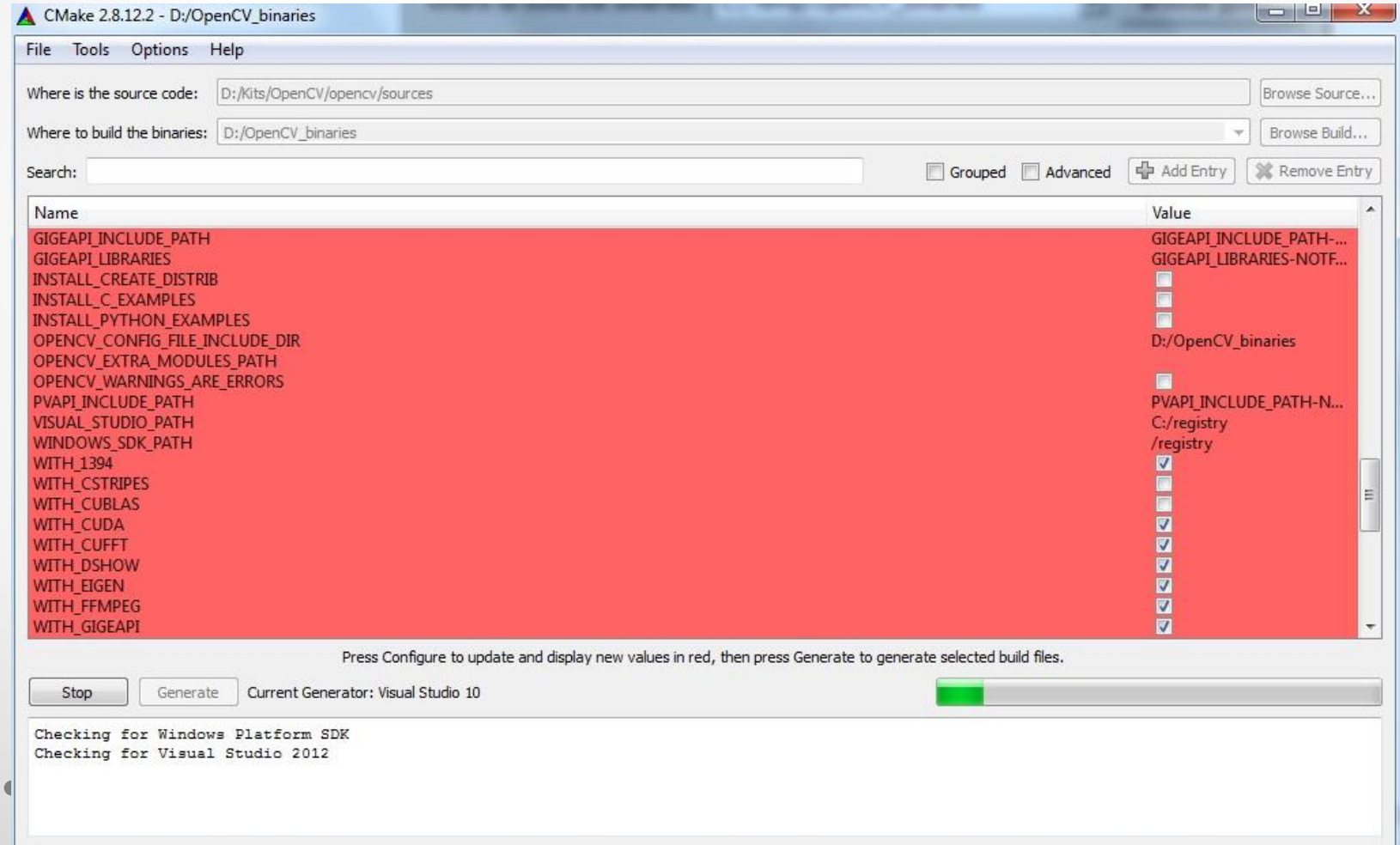
# Instalarea OpenCV

- Se obtine o fereastra ca mai jos.
- Apasam din nou **Configure.**



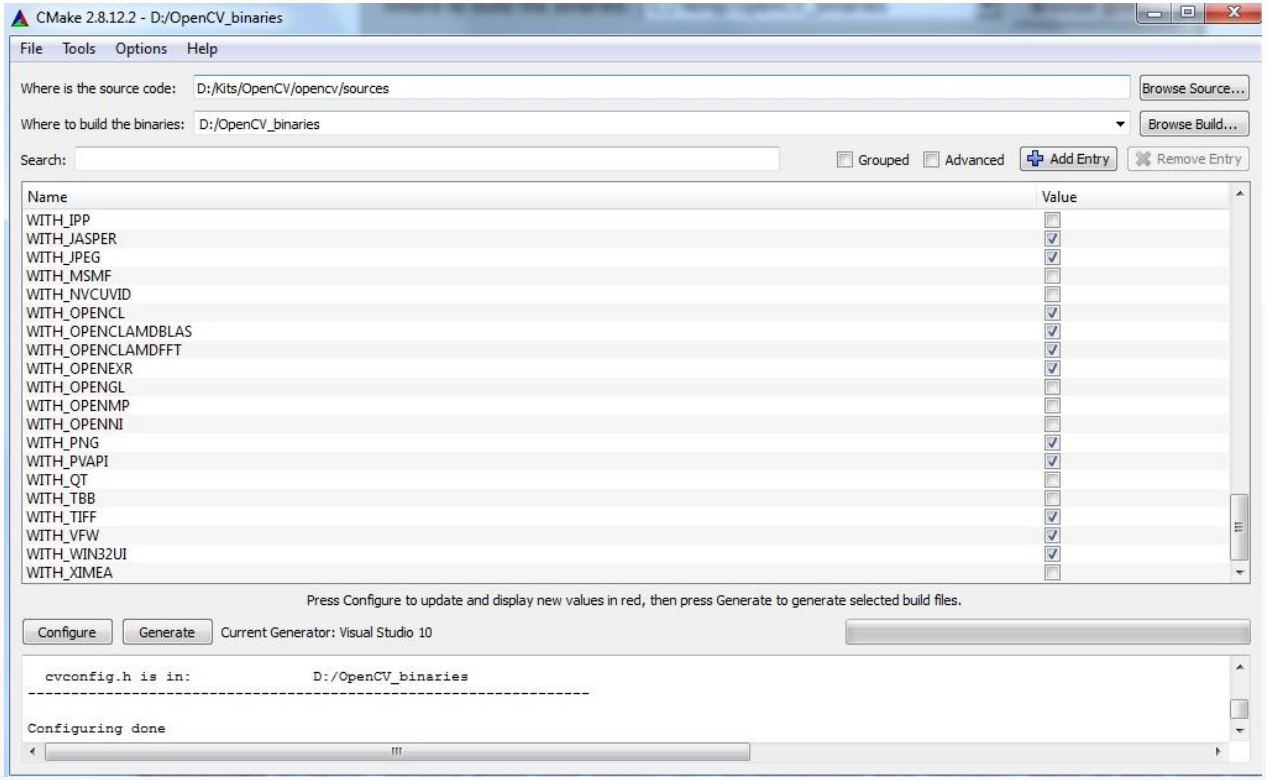
# Instalarea OpenCV

- Dupa ce a fost apasat din nou **Configure**



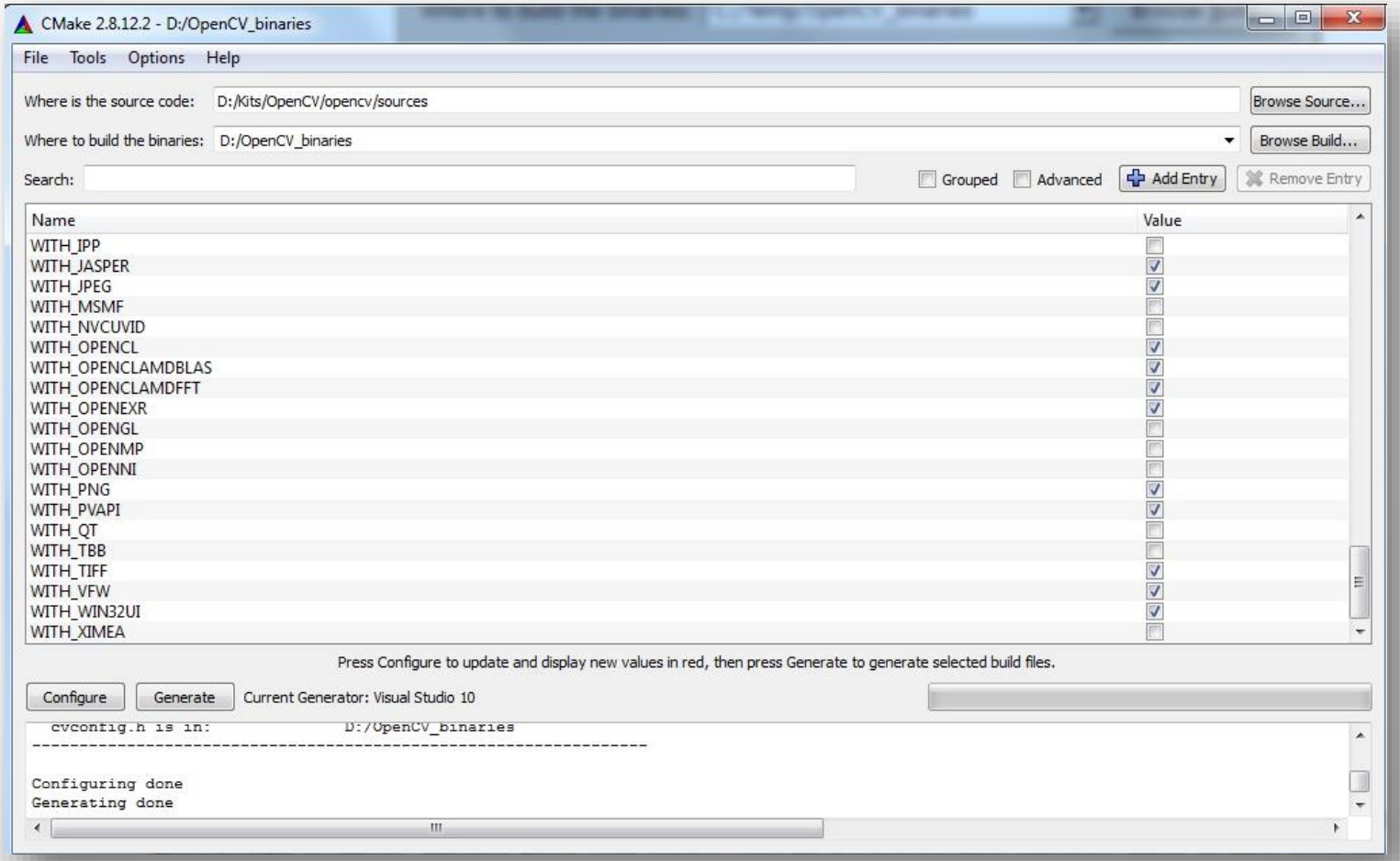
# Instalarea OpenCV

- Configurarea este gata. Acum apasam din nou **Generate**



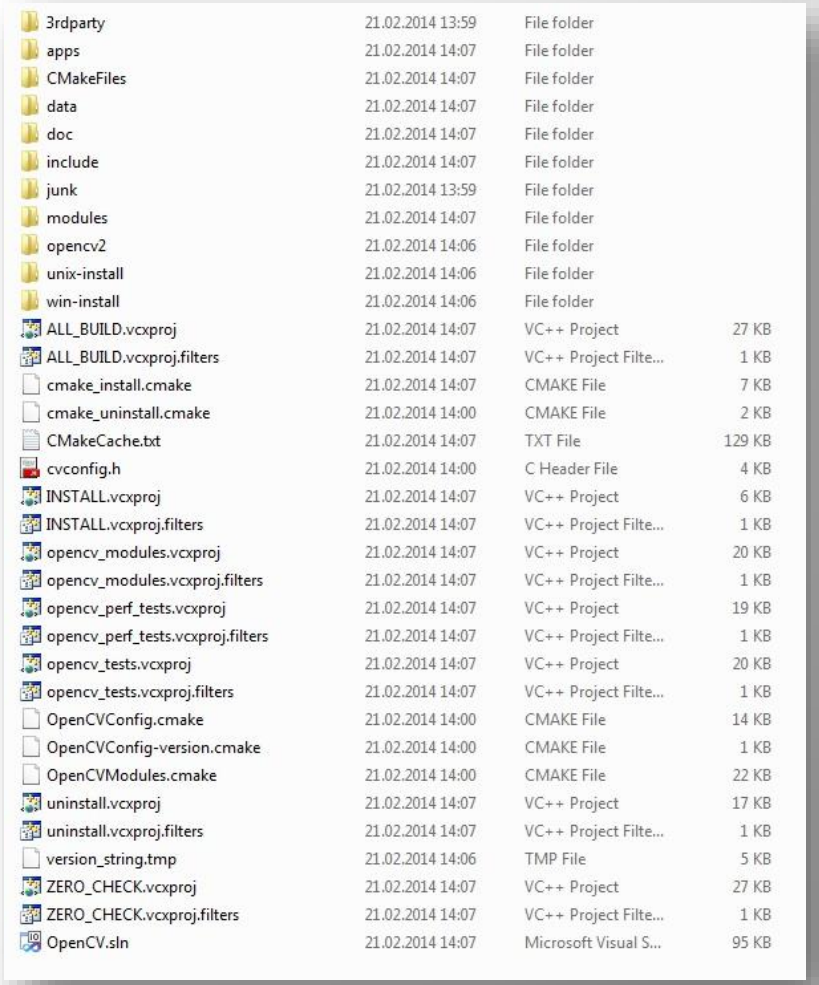
# Instalarea OpenCV

- Gata si generarea



# Instalarea OpenCV

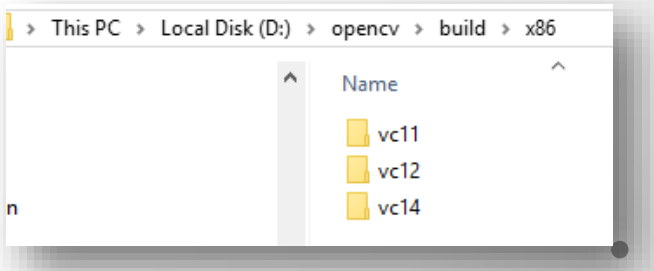
- Verificam folderul in care am trimis libraria
  - Dam dublu-click pe OpenCV.sln (solutia creata) pentru a o deschide in Microsoft Studio 2010 (sau ce versiune avem)
  - Dam Build Solution atat cu *Debug*, cat si cu *Release*
    - Dureaza in general peste 5 minute…



| | | | |
|---|---|---|---|
| 3rdparty | 21.02.2014 13:59 | File folder | |
| apps | 21.02.2014 14:07 | File folder | |
| CMakeFiles | 21.02.2014 14:07 | File folder | |
| data | 21.02.2014 14:07 | File folder | |
| doc | 21.02.2014 14:07 | File folder | |
| include | 21.02.2014 14:07 | File folder | |
| junk | 21.02.2014 13:59 | File folder | |
| modules | 21.02.2014 14:07 | File folder | |
| opencv2 | 21.02.2014 14:06 | File folder | |
| unix-install | 21.02.2014 14:06 | File folder | |
| win-install | 21.02.2014 14:06 | File folder | |
| ALL_BUILD.vcxproj | 21.02.2014 14:07 | VC++ Project | 27 KB |
| ALL_BUILD.vcxproj.filters | 21.02.2014 14:07 | VC++ Project Filte... | 1 KB |
| cmake_install.cmake | 21.02.2014 14:07 | CMAKE File | 7 KB |
| cmake_uninstall.cmake | 21.02.2014 14:00 | CMAKE File | 2 KB |
| CMakeCache.txt | 21.02.2014 14:07 | TXT File | 129 KB |
| cvconfig.h | 21.02.2014 14:00 | C Header File | 4 KB |
| INSTALL.vcxproj | 21.02.2014 14:07 | VC++ Project | 6 KB |
| INSTALL.vcxproj.filters | 21.02.2014 14:07 | VC++ Project Filte... | 1 KB |
| opencv_modules.vcxproj | 21.02.2014 14:07 | VC++ Project | 20 KB |
| opencv_modules.vcxproj.filters | 21.02.2014 14:07 | VC++ Project Filte... | 1 KB |
| opencv_perf_tests.vcxproj | 21.02.2014 14:07 | VC++ Project | 19 KB |
| opencv_perf_tests.vcxproj.filters | 21.02.2014 14:07 | VC++ Project Filte... | 1 KB |
| opencv_tests.vcxproj | 21.02.2014 14:07 | VC++ Project | 20 KB |
| opencv_tests.vcxproj.filters | 21.02.2014 14:07 | VC++ Project Filte... | 1 KB |
| OpenCVConfig.cmake | 21.02.2014 14:00 | CMAKE File | 14 KB |
| OpenCVConfig-version.cmake | 21.02.2014 14:00 | CMAKE File | 1 KB |
| OpenCVModules.cmake | 21.02.2014 14:00 | CMAKE File | 22 KB |
| uninstall.vcxproj | 21.02.2014 14:07 | VC++ Project | 17 KB |
| uninstall.vcxproj.filters | 21.02.2014 14:07 | VC++ Project Filte... | 1 KB |
| version_string.tmp | 21.02.2014 14:06 | TMP File | 5 KB |
| ZERO_CHECK.vcxproj | 21.02.2014 14:07 | VC++ Project | 27 KB |
| ZERO_CHECK.vcxproj.filters | 21.02.2014 14:07 | VC++ Project Filte... | 1 KB |
| OpenCV.sln | 21.02.2014 14:07 | Microsoft Visual S... | 95 KB |

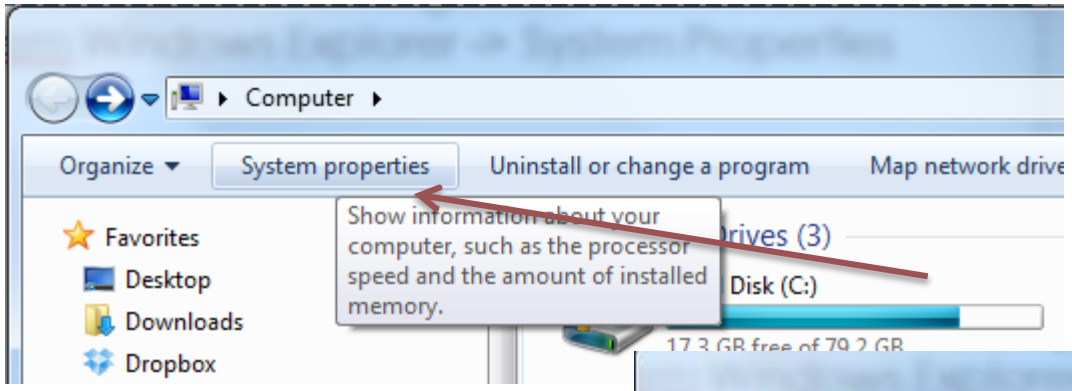
# Daca avem Visual Studio 2015 si OpenCV 3.0

- Este necesar sa generam folderul vc14 prin o compilare aditionala.
- Tot in cadrul OpenCV.sln, alegem din cadrul Folderului CMakeTargets fisierul INSTALL
  - Cu click dreapta pe el alegem Build (o data cu *debug* si o data cu *release*)
- Cautam apoi in Windows Explorer, in folderul *install*, la versiunea x64 sau x86, dupa caz, folderul vc14.
  - Acesta se copiaza in folderul build, apoi x64 sau x86, dupa caz.
  - Acolo va sta langa folderele deja compilate existente, de exemplu vc11 si vc12.
- In continuare, caile vor fi date in functie de ce Visual Studio avem:
  - VS15 -> vc14
  - VS13 -> vc12
  - VS12 -> vc11 etc

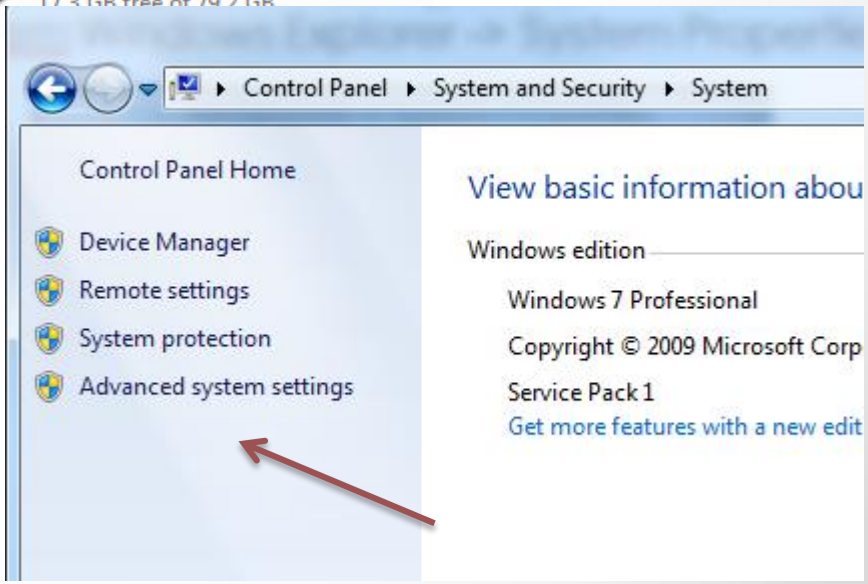


# Instalarea OpenCV
# Setare variabile de mediu

- Alegem Windows Explorer -> System Properties

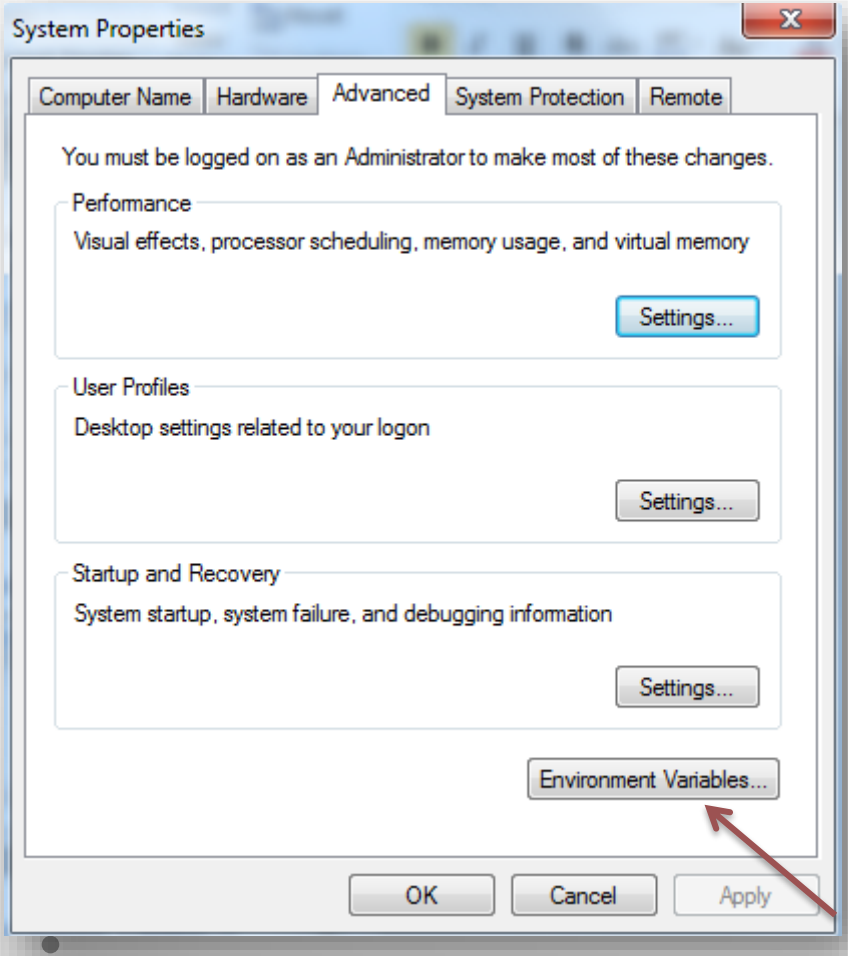



- Apoi **Advanced system settings**

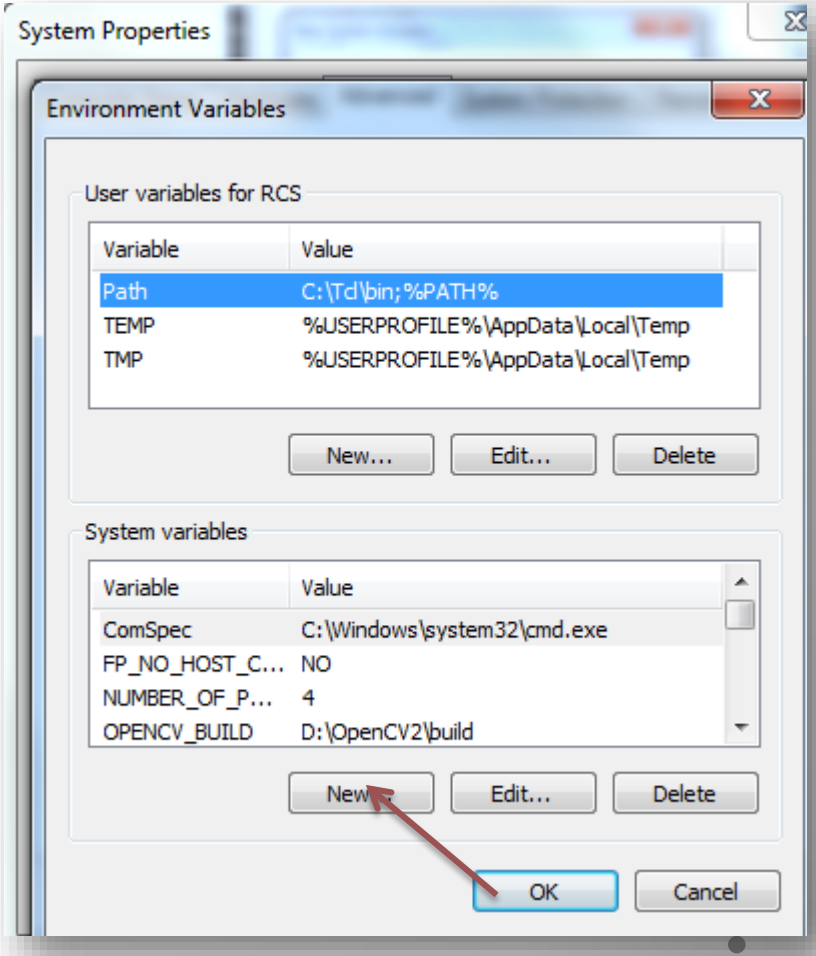


# Instalarea OpenCV
# Setare variabile de mediu

- Environment Variables

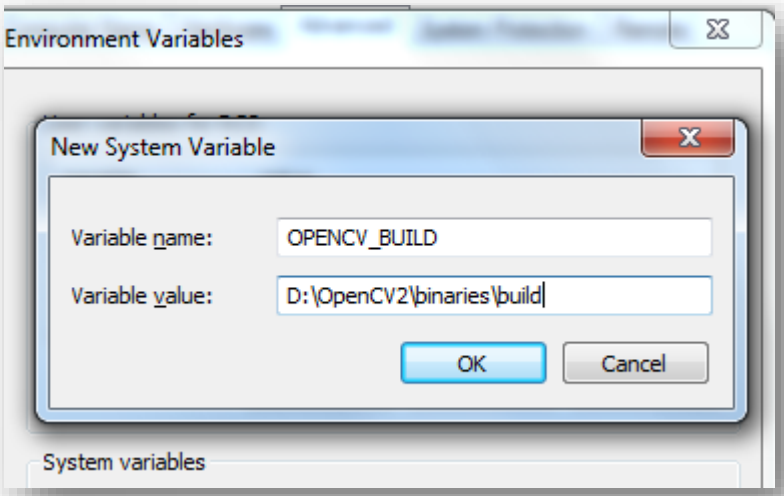


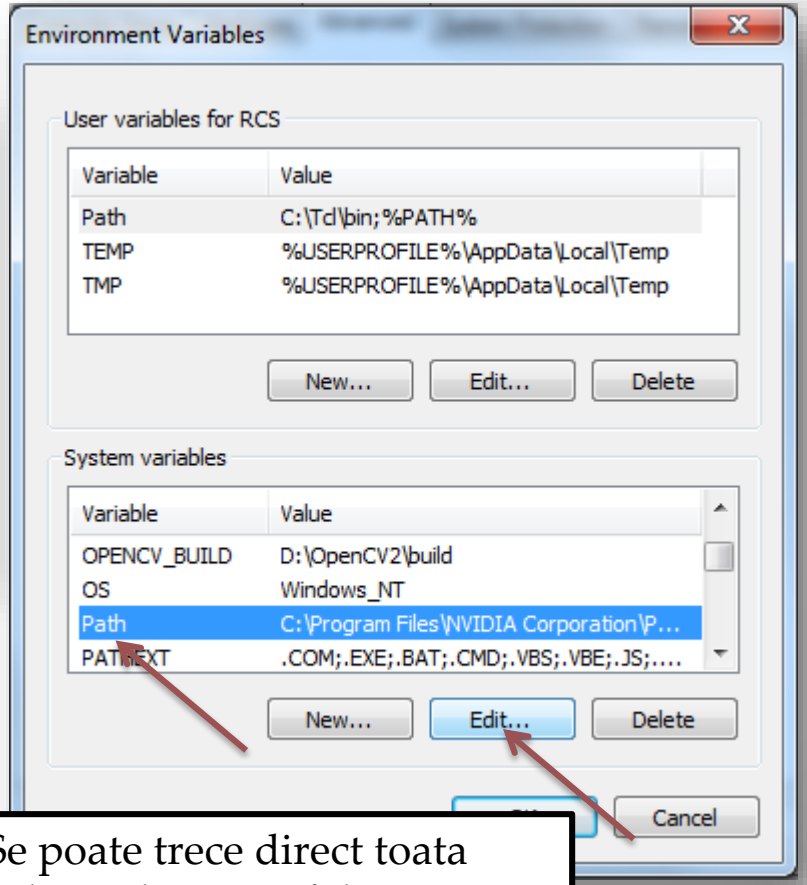

- Cream o variabila de sistem

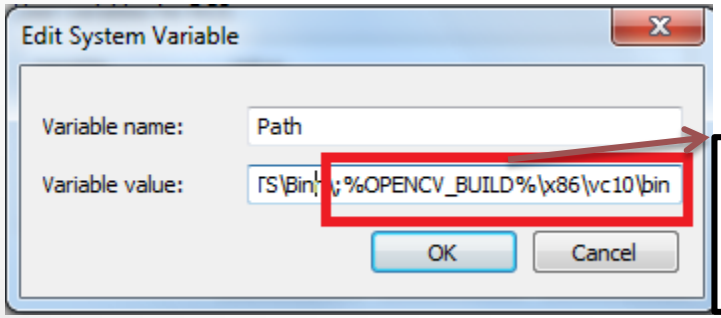


# Instalarea OpenCV
# Setare variabile de mediu

- Environment Variables



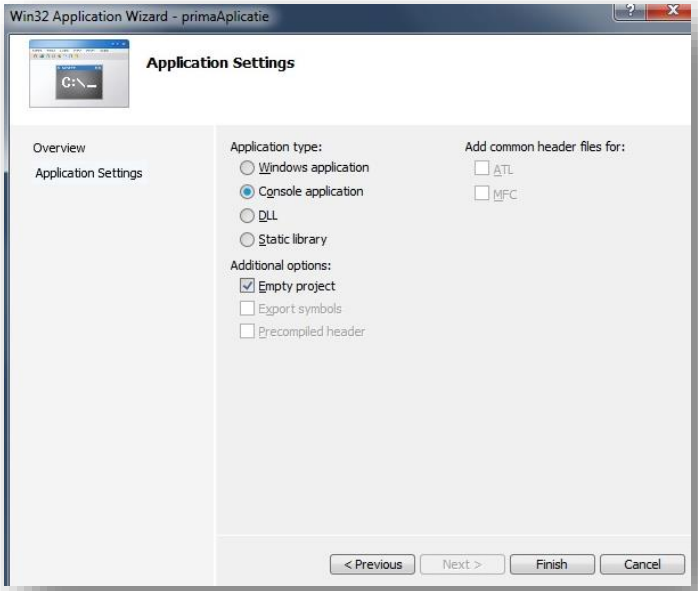




Se poate trece direct toata calea in loc sa se foloseasca variabila de mediu

Daca IDE este pe 64 de biti, se alege folderul x64 in loc de x86.

# Proiect OpenCV folosind Visual Studio 10

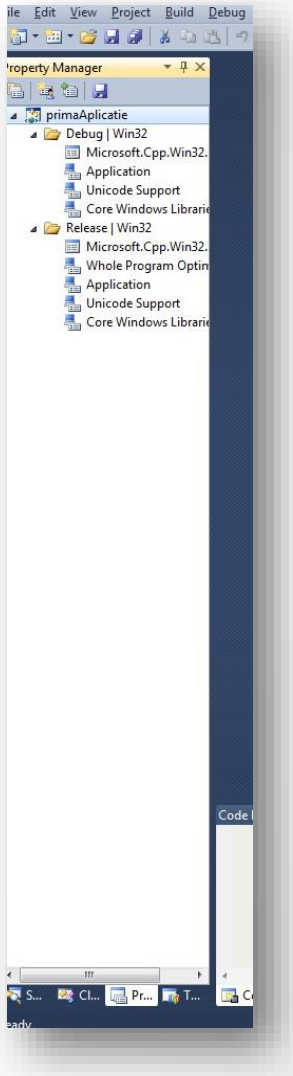
- Cream un proiect de tip **Console Application**, **Empty project**, fara precompiled header.




- In continuare, trebuie sa specificam unde se gasesc librariile OpenCV.

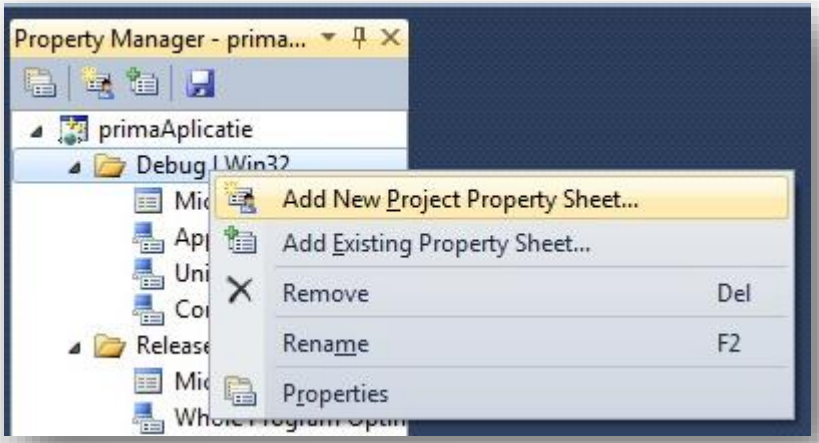
# Proiect OpenCV folosind Visual Studio 10

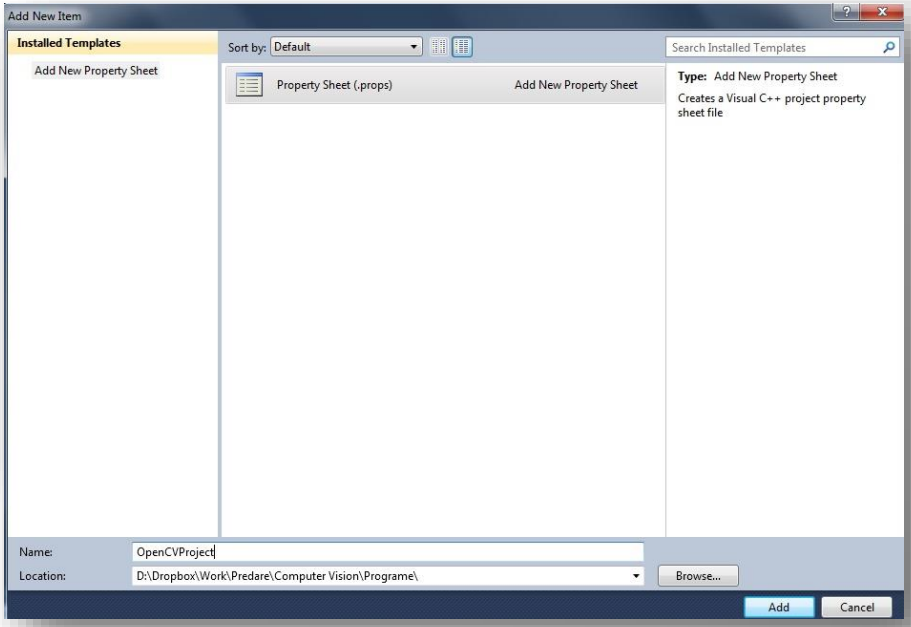
- Cea mai buna optiune pentru a specifica unde se gasesc librariile OpenCV este sa cream un **Property Sheet** pe care sa il putem utiliza si in alte proiecte.
- Pentru aceasta, mergem la Property Manager.
  - Avem de adaugat cate unul pentru **Debug** si **Release**.



# Property Sheet

- Click-dreapta pe Debug si selectam **Add New Property Sheet…**
- In fereastra care se deschide ii punem un nume, de exemplu **OpenCVDebug**, apoi **Add**.

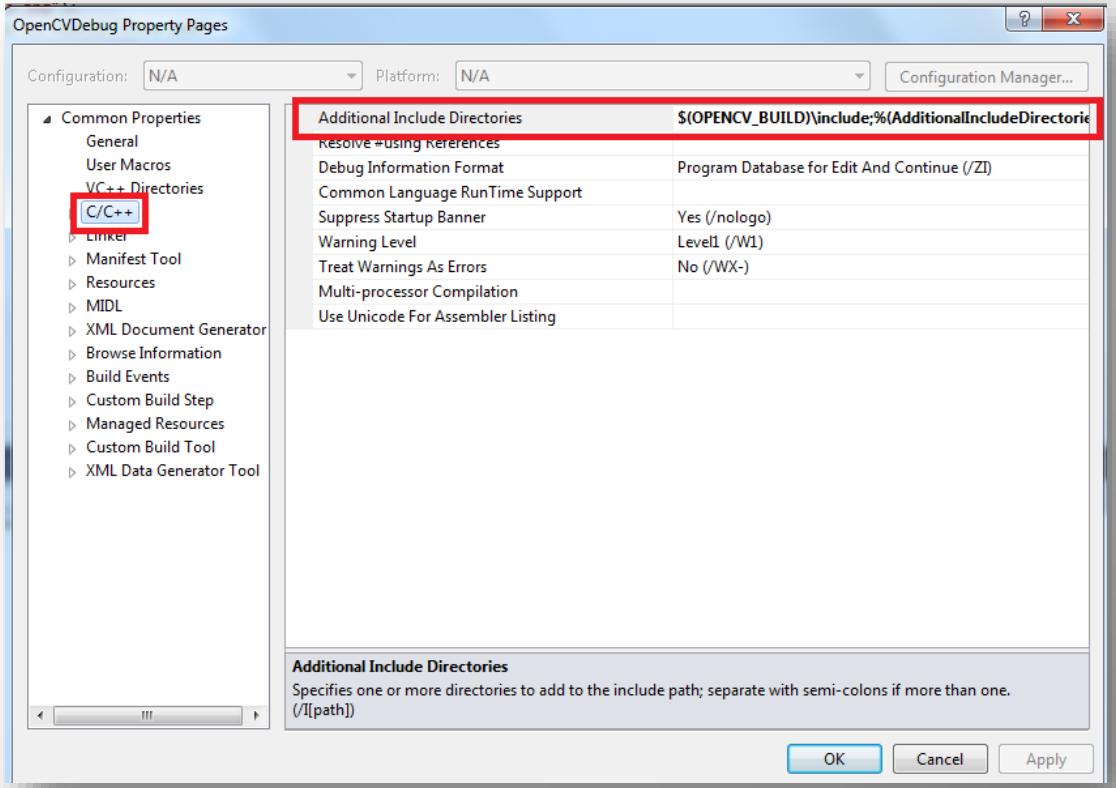


# Property Sheet

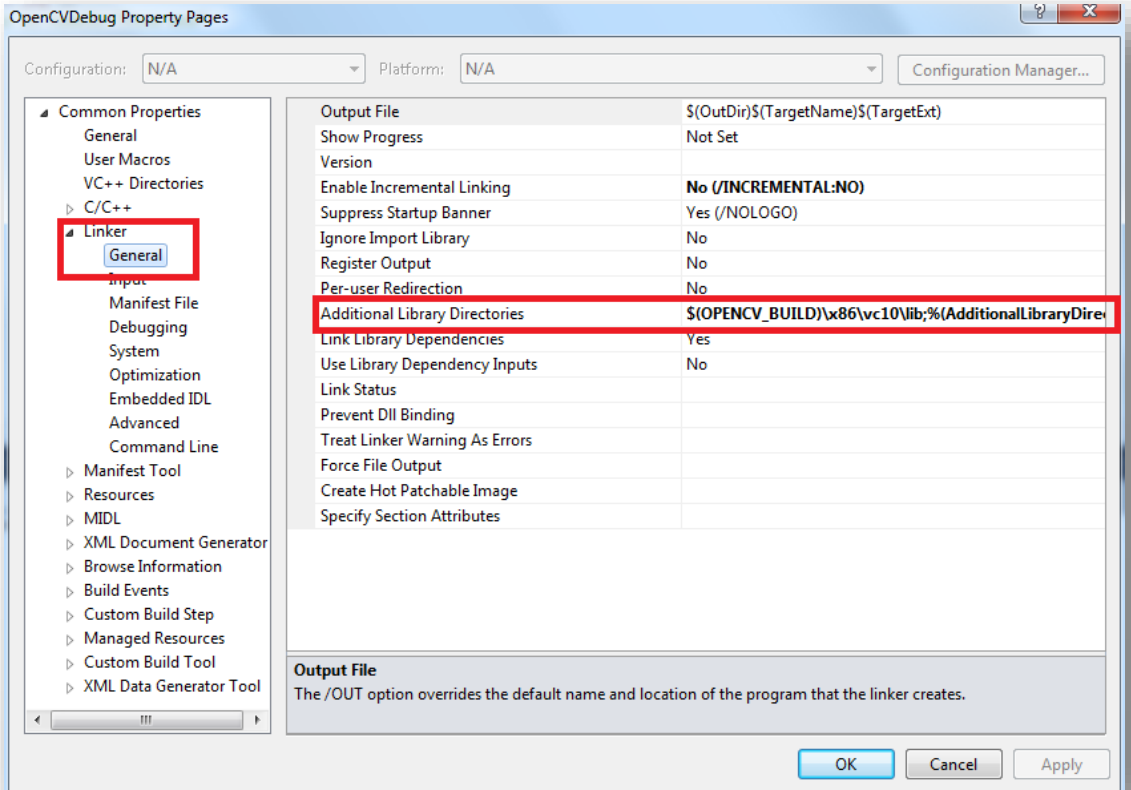
- Dublu-click pe noul property sheet creat, **OpenCVDebug**.
- La **C/C++**, alegem **Additional Include Directories**, apasam **Edit** si in fereastra deschisa adaugam **$(OPENCV_BUILD)\include**
  - Astfel furnizam calea catre bibliotecile din OpenCV pe care le vom utiliza

In loc de **$(OPENCV_BUILD)** se poate pune direct calea catre folderul **build**.



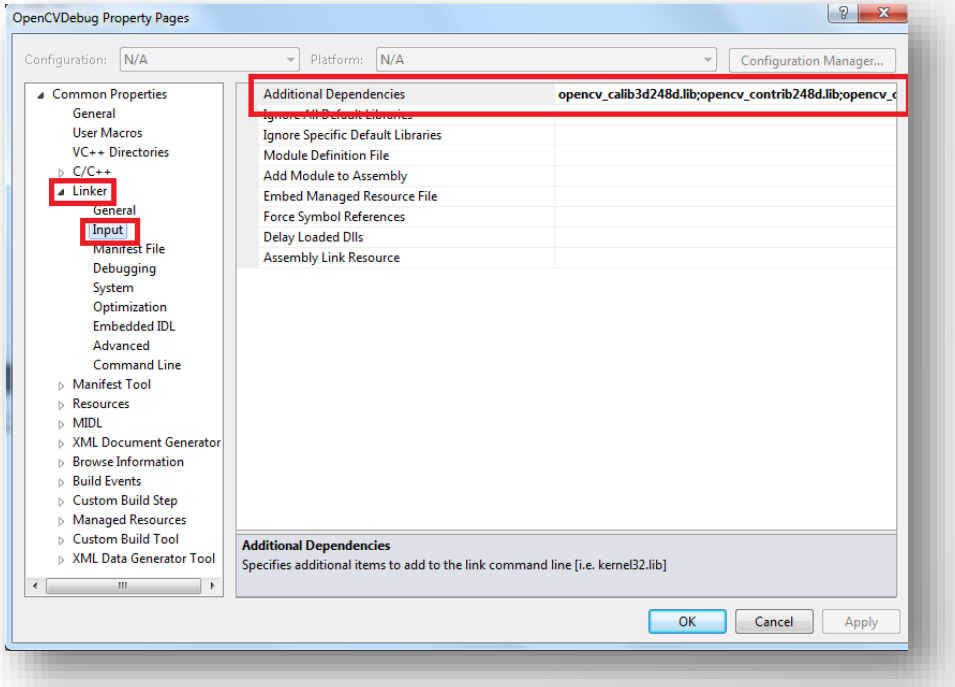
# Property Sheet

- Mergem apoi la **Linker** -> **General** -> **Additional Library Directories**, apasam **Edit…** si introducem **$(OPENCV_BUILD)\x86\vc10\lib**.
  - Din nou, daca avem IDE pe 64 de biti alegem folderul **x64**.



# Property Sheet

- Tot la **Linker**, **Input** si **Additional Dependencies**, **Edit**.
- Daca avem OpenCV 3.0 si Visual Studio 2012 sau 2013 adaugam in fereastra care se deschide:



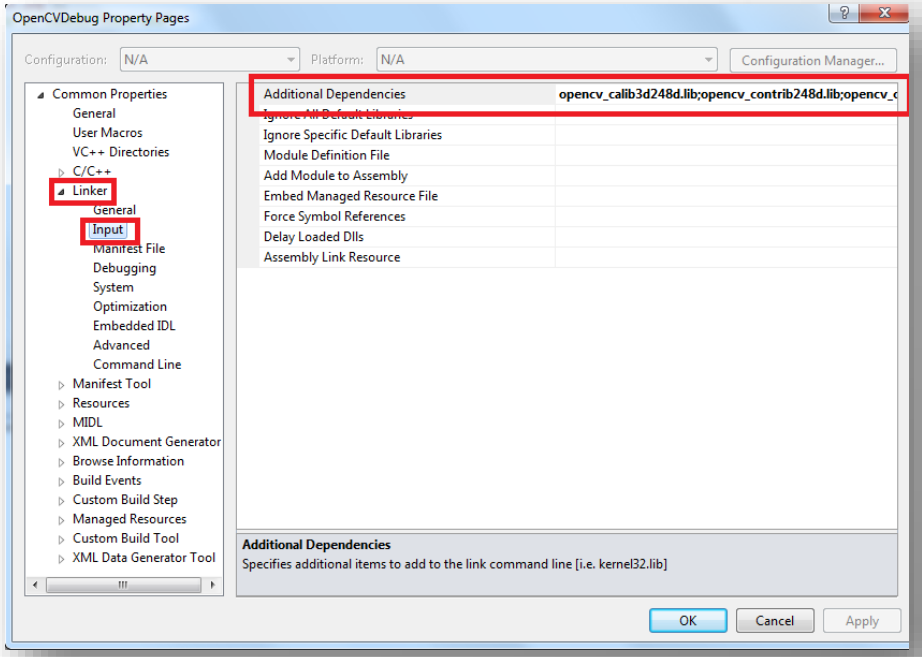

- opencv_ts300d.lib
- opencv_world300d.lib

- 300 vine de la versiunea OpenCV. Daca aveti o versiune diferita, schimbati valorile.
- Librariile se mai pot schimba de la o librarie la alta
  - se pot introduce unele noi si/sau scoate altele existente anterior.

# Property Sheet

- Tot la **Linker**, **Input** si **Additional Dependencies**, **Edit**.
- Daca avem OpenCV 3.0 si Visual Studio 2015 (cu librarii generate dupa indicatiile de la slide-ul 20) librariile sunt:

- opencv_calib3d300d.lib
- opencv_core300d.lib
- opencv_features2d300d.lib
- opencv_flann300d.lib
- opencv_highgui300d.lib
- opencv_imgproc300d.lib
- opencv_ml300d.lib
- opencv_objdetect300d.lib
- opencv_photo300d.lib
- opencv_stitching300d.lib
- opencv_ts300d.lib
- opencv_video300d.lib
- opencv_videostab300d.lib
- opencv_imgcodecs300d.lib

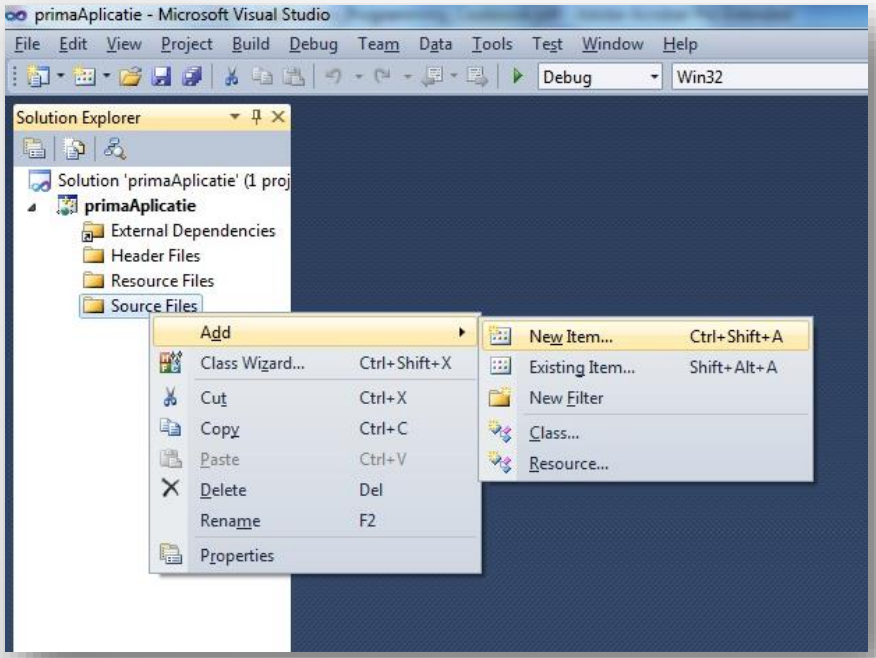


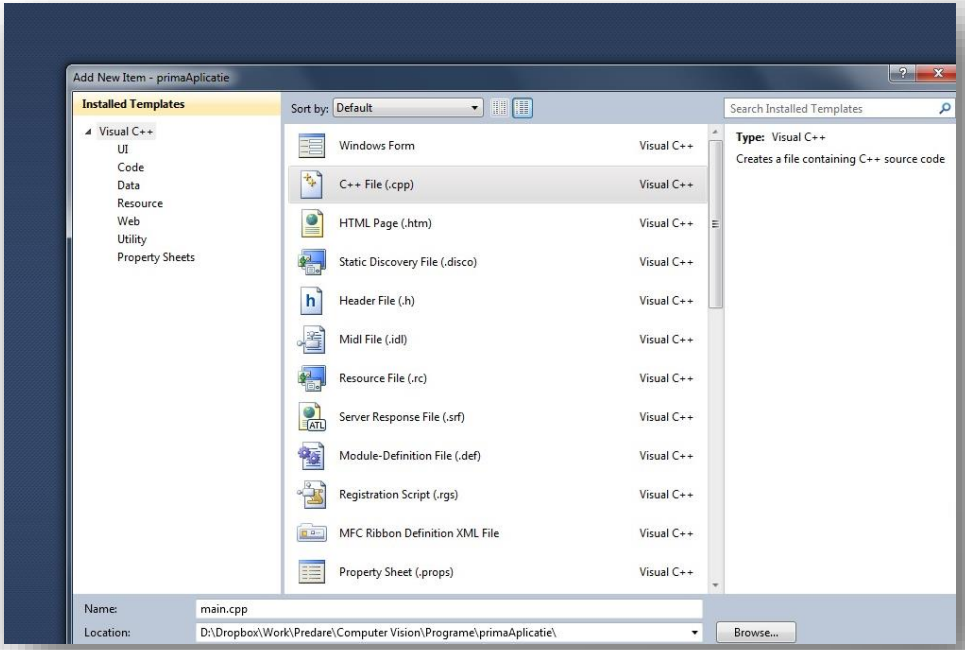
# Property Sheet

- Caracterul *d* de la finaul librariilor de pe slide-ul anterior vine de la **debug**.
- Cum am facut pentru Debug va trebui sa facem si pentru varianta de Release.
  - **Add New Property Sheet** cu numele **OpenCVRelease**
  - **C/C++** -> **Additional Include Directories**
  - **Linker** -> **General** -> **Additional Library Directories**
  - **Linker** -> **Input** -> **Additional Dependencies**
    - opencv_ts300.lib
    - opencv_world300.lib

  Sau, pentru Visual Studio 2015 cu generarea de la slide-ul 20:
    - opencv_calib3d300.lib
    - opencv_core300.lib
    - …
    - **Toate fara *d*-ul de la final**

# Proiect OpenCV folosind Visual Studio 10



# Build si Run

- Daca nu merge si nu identificati o eroare de sintaxa, trebuie reluati pasii anteriori. ☺

main.cpp

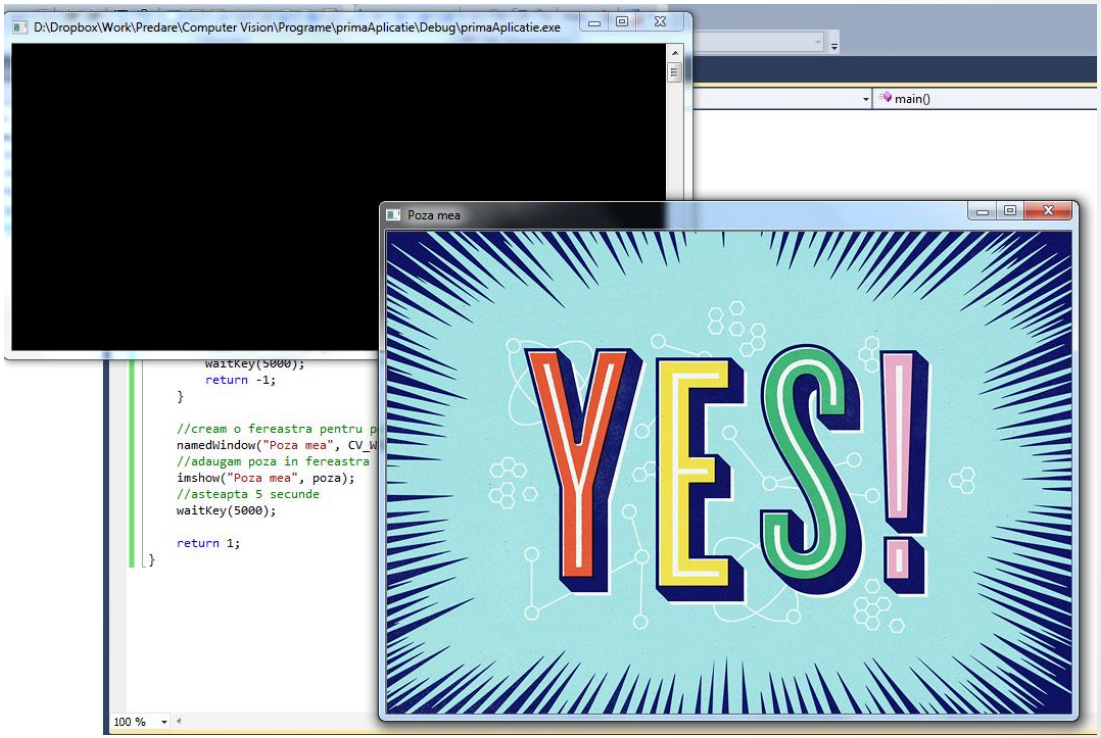
(Global Scope)

```
#include <iostream>
#include <opencv2/core/core.hpp>
#include <opencv2/highgui/highgui.hpp>

using namespace std;
using namespace cv;

int main()
{
    //citim o imagine
    Mat poza = imread("D:/poza.jpg");

    if(! poza.data )                              // Verific daca citirea este valida
    {
        cout <<  "Nu am gasit poza" << endl ;
        waitKey(5000);
        return -1;
    }

    //cream o fereastra pentru poza cu numele "Poza mea"
    namedWindow("Poza mea", CV_WINDOW_AUTOSIZE);
    //adaugam poza in fereastra
    imshow("Poza mea", poza);
    //asteapta 5 secunde
    waitKey(5000);

    return 1;
}
```

Pentru OpenCV 3.0 adaugati
#include <opencv2/imgcodecs.hpp>
imread a fost mutate in imgcodecs.hpp

# Ce face programul

- Afiseaza o poza



# Proiect OpenCV folosind QT

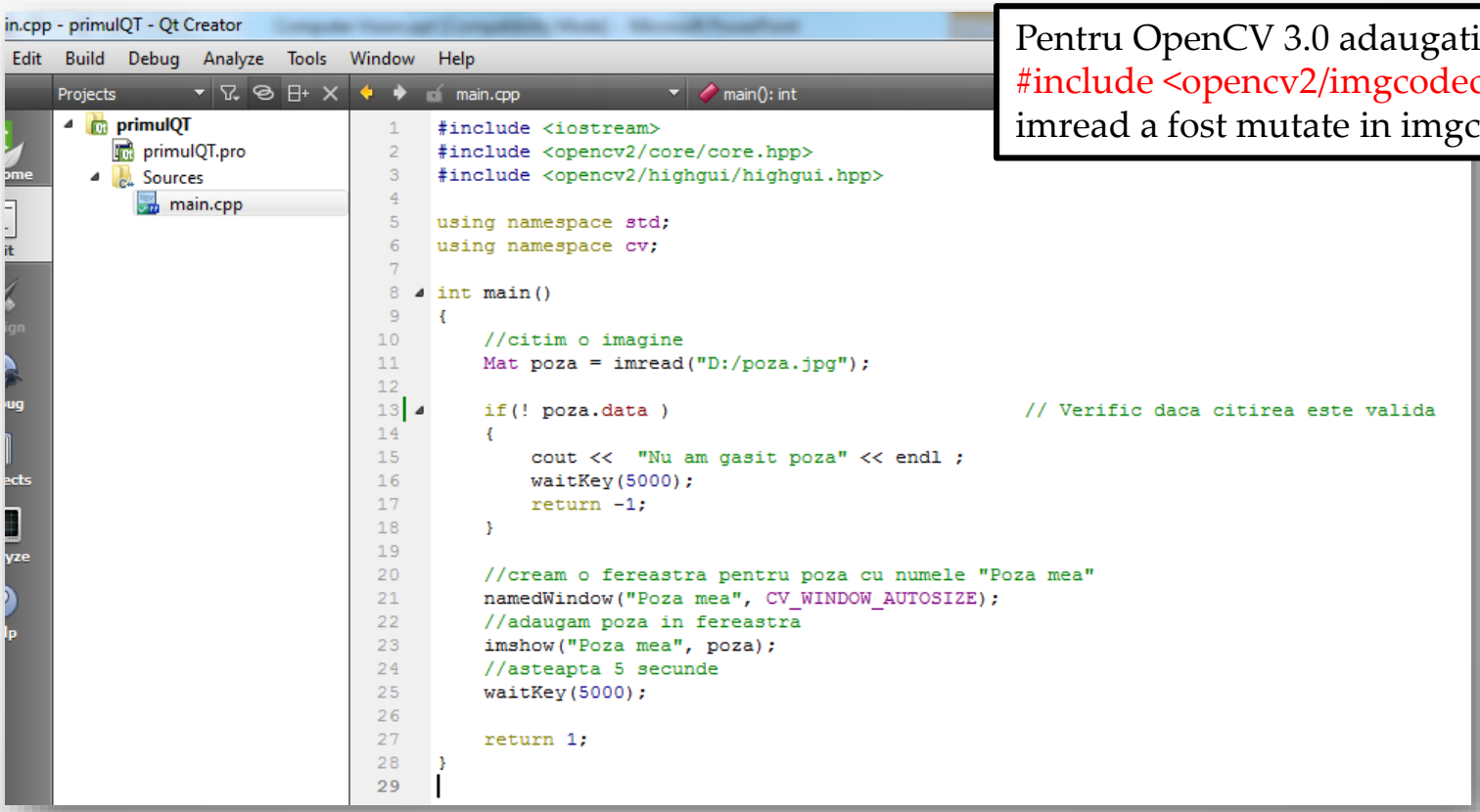
- QT se descarca de la

  http://qt-project.org/downloads

- Dezvoltat de compania norvegiana Trolltech si cumparat de Nokia in 2008.
- Open source
- Cross-platform

# Proiect OpenCV folosind QT

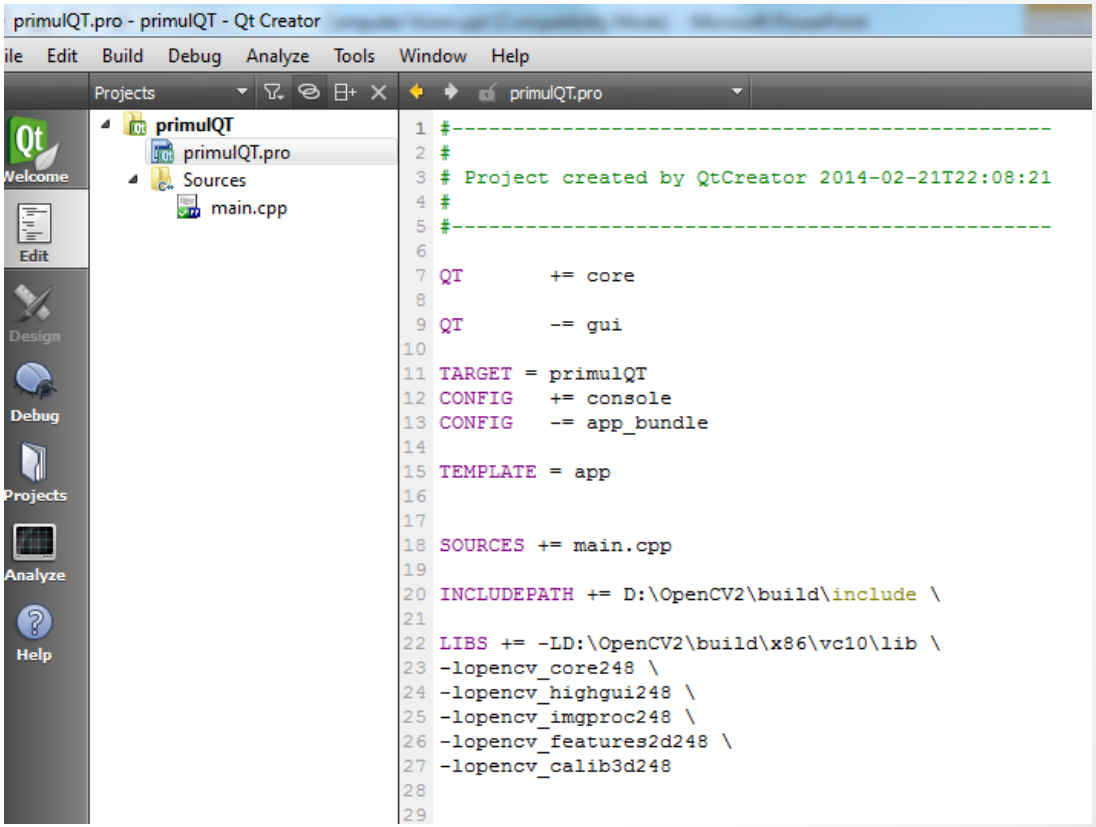
- Cream un proiect de tip **Console Application**.



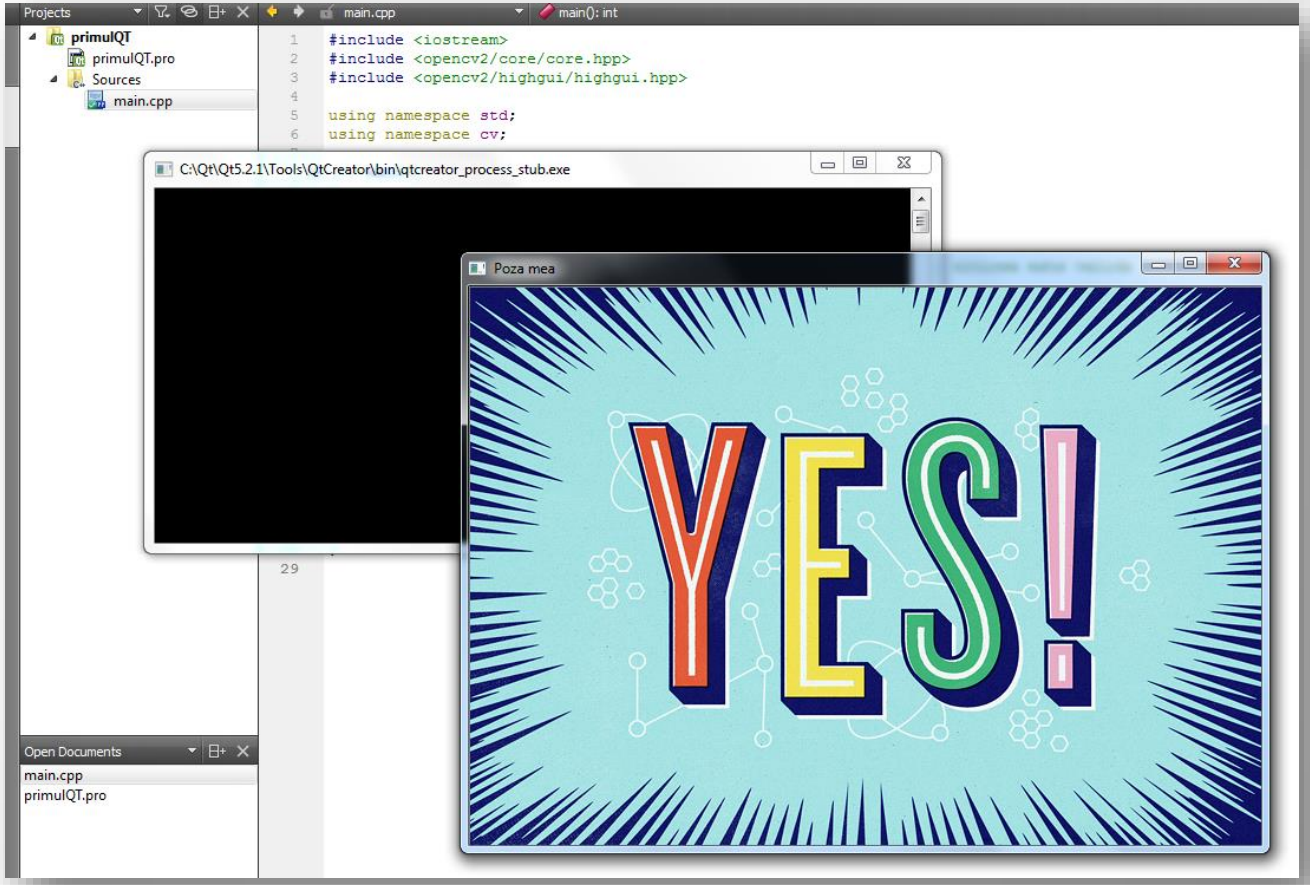

Pentru OpenCV 3.0 adaugati
#include <opencv2/imgcodecs.hpp>
imread a fost mutate in imgcodecs.hpp

# Proiect OpenCV folosind QT

- In fisierul .pro se specifica calea catre folderul **include** si catre librarii.
- Din meniul Build, dam Run qmake.
- Nu este nevoie de setari aditionale.



# Proiect OpenCV folosind QT



# Exercitii

- Folosind documentatia OpenCV, modificati programul anterior pentru a:
  - Stabili pentru fereastra in care s-a afisat imaginea dimensiunea 800x600
  - Citi o poza in format Grayscale.
  - Salva cu un alt nume poza citita in format Grayscale
  - Scrie la consola cati pixeli are o poza in lungime si cati are in latime
  - Afisa imaginea citita intr-o fereastra de dimensiuni la jumatate din marimile sale originale.