Technical University of Cluj - Napoca
Computer Science Department

Procesarea Imaginilor

(An 3, semesterul 2)

Curs 1: Introducere

Info

Evaluare

Examen scris – 50% din nota (nota minima 5)

Laborator + proiect – 50% din nota (nota minima 5)

Prezenta la laborator/proiect – obligatorie!

Laborator – evaluare dupa fiecare laborator + teste

Proiect – evaluare dupa fiecare faza de proiectare (specifice, analiza, design logic, implementare, tetsare si validare).

Documentatii (curs & laborator)

http://users.utcluj.ro/~tmarita/IPL/IPCurs/IPCurs.htm

http://users.utcluj.ro/~tmarita/IPL/IPLab/IPLAB.htm

Retea Dorobantilor 71-73: \\D110-13\Users\Public\Public Documents\PI

Paginile personale ale lectorilor / indrumatorilor de laborator

http://www.cv.utcluj.ro/home.html

Bibliografie curs

R.C.Gonzales, R.E.Woods, *Digital Image Processing – 2-nd Edition*, Prentice Hall, 2002.

E. Trucco, A. Verri, *Introductory Techniques for 3-D Computer Vision*, Prentice Hall, 1998.

W.K. Pratt, *Digital Image Processing: PIKS Inside, 3-rd Edition,* Wiley & Sons 2001.

G. X.Ritter, J.N. Wilson, Handbook of computer vision algorithms in image algebra - 2nd ed, CRC Press, 2001.

Frank Y. Shih, *Image Processing And Pattern Recognition - Fundamentals and Techniques*, Wiley & Sons, Hoboken, New Jersey, 2010.

A. Koschan, M. Abidi, *Digital Color Image Processing*, Wiley & Sons, 2008.

H.C. Lee, *Introduction to Color Image Science*, Cambridge University Press 2005

D. Forsyth, J. Ponce, *Computer Vision. A Modern Approach*, Prentice Hall, 2002.

L. G. Shapiro, G. C. Stockman, *Computer Vision*, Prentice Hall, 2000

Bibl. UTCN:

S.Nedevschi, "Prelucrarea imaginilor si recunoasterea formelor", *Ed. Microinformatica, 1997.*

S. Nedevschi, R. Dănescu, F. Oniga, T. Mariţa, *Tehnici de viziune artificială aplicate în conducerea automată a autovehiculelor, Editura U.T. Press, Cluj-Napoca, 2012.*

S. Nedevschi, T. Mariţa, R. Dănescu, F. Oniga, R. Brehar, I. Giosan, C. Vicaș, *Procesarea Imaginilor - Îndrumător de laborator, Editura U.T. Press, Cluj-Napoca, 2013.*

S. Nedevschi, T. Marita, R. Danescu, F. Oniga, R. Brehar, I. Giosan, S. Bota, A. Ciurte, A. Vatavu, „Image Processing - Laboratory Guide”, UTPress Edition, 2016, ISBN 978-606-737-137-6, http://biblioteca.utcluj.ro/carti-online.html

Viziunea artificala

Vizunea artificiala (Computer Vision)?

Viziunea artificiala este un domeniu/disciplina care infereaza date/informatie din imagini cu ajutorul metodelor matematice, geometrice, statistice, ale fizicii si a teoriei invatarii automate (machine learning)

Se bazeaza pe:

- Cunoasterea profunda a modelului camerei si al procesului de formare al imaginii pentru a obtine inferente simple de la valorile pixelilor individuali pana la combinarea informatiei de la imagini multiple pentru a obtine un tot unitar coerent

- Impunerea anumitor ordonari asupra unor grupe de pixeli pentru ai separa sau grupa intre ei sau pentru a infera informatia de forma si a recunoaste obiecte pe baza trasaturilor geometrice.

Alte denumiri

- analiza de imagini (image analysis)
- analiza scenei (scene analysis)
- interpretarea imaginilor (image understanding)

Viziunea artificala

Disipline conexe

- Inteligenta artificiala (artificial intelligence)
- Robotica (robotics)
- Procesarea semnalelor (signal processing)
- Recunoasterea de forme (pattern recognition)
- Teoria controlului (control theory)
- Psihologia (psychology)
- Neurostiintele (neuroscience)

Subdomenii:

- Procesarea imaginilor
- Recunoasterea formelor
- Fotogrametria (discipline care se ocupa cu inferarea informatiei metrice /masuratori: calibrarea camerelor, stereoviziunea, reconstrcuctia 3D detectia de obiecte)
- Analiza statica/dinamica a imaginilor, trasaturilor, obiectelor

Procesarea imaginilor

Procesarea imaginilor (Image Processing)

- Se ocupa cu studiul *proprietatilor imaginilor* si cu *transformarea acestora* (a imaginilor)

- Majoritatea algoritmilor de viziune artificala necesita folosirea unor algoritmi de procesare a imaginilor

Example de metode:

• imbunatatirea calitatii imaginilor (image enhancement) – prin transformarea imaginilor: punerea in evidenta a detaliilor ascune/obscure, a trasaturilor de interes

• compresia (reprezentare compacta a imginilor/secventelor pentru transmisie / stocare)

• restaurarea (eliminarea elementelor de degradare cunoscute / modelabile)

• extragerea de trasaturi (localizarea anumitor sabloane – ex: muchii, colturi, structuri complexe - obiecte)

Viziunea artificiala

Domenii de cercetare:

- Detectia de trasaturi (Feature Detection
- Representarea conturelor (Contour Representation)
- Analiza imaginilor de profunzime (Range image analysis)
- Modelarea si reprezentarea formelor (Shape modeling and representation)
- Stereo viziunea (Stereo vision)
- Viziunea color (Color vision)
- Vizunea activa (Active/Purposive vision)
- Invarianti (Invariants)
- Detectia obiectelor (Object detection)
- Analiza miscarii (Motion analysis)
- Urmarirea miscarii obiectelor (Tracking)
- Recunoastera obiectelor 3D (3D object recognition)
- Adnotarea semantica a imaginilor/video (Image annotation)
- Aritectura sistemelor de viziune (Vision architectures)

Viziunea artificiala

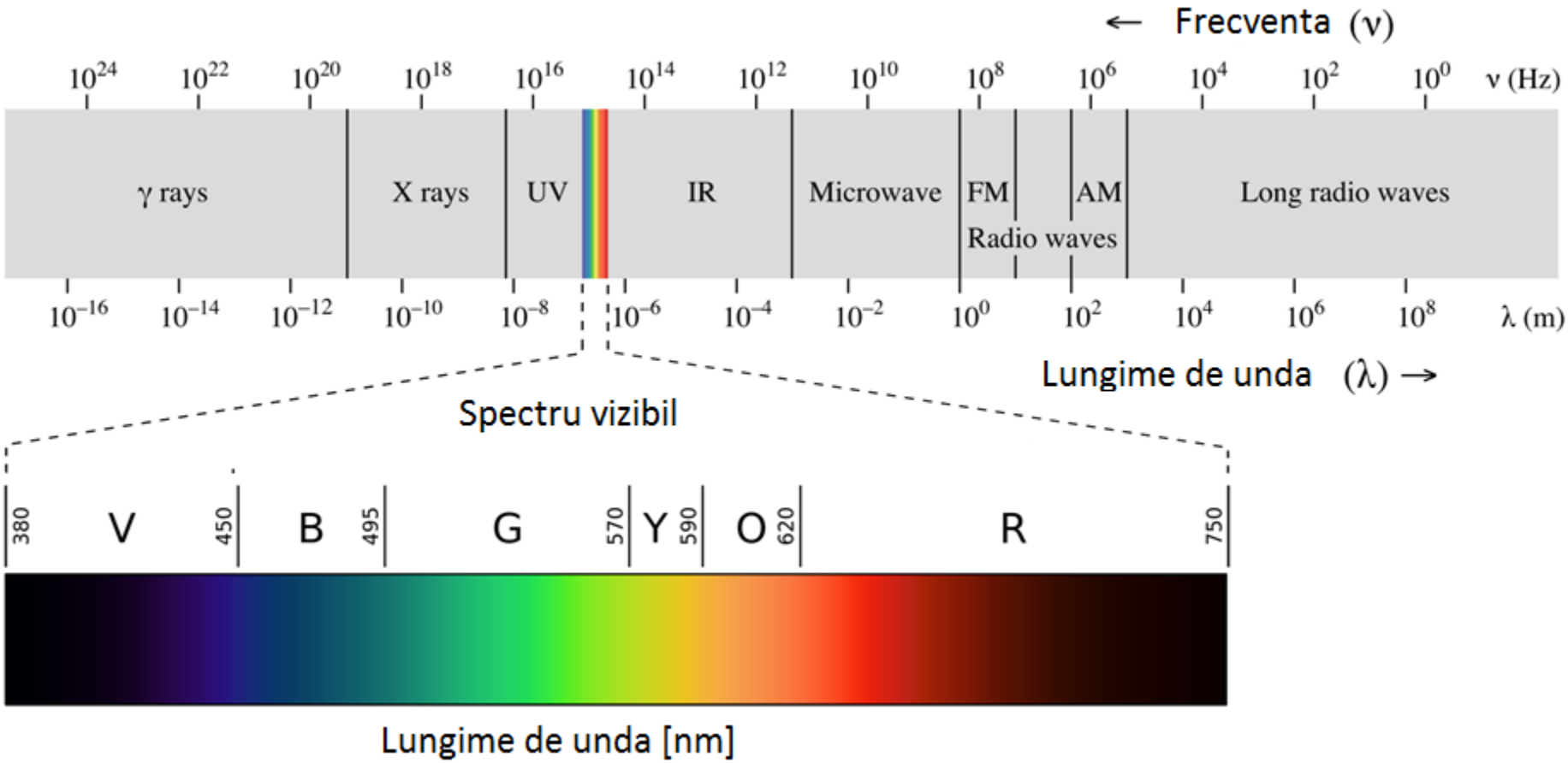
Domenii de aplicare

- Inspectie industriala / controlul calitatii (Industrial inspection/quality control)
- Inginerie inversa (reverse engineering)
- Supraveghere si securitate (Surveillance and security)
- Aplicatii biometrice:recunoastera fetei (Face recognition), amprentelor ..)
- Interactiune om-calculator: recunoasterea gesturilor (Gesture recognition)
- Monitorizarea traficului (Road monitoring)
- Aplicatii spatiale (Space applications)
- Analiza imaginilor medicale (Medical image analysis)
- Realitate virtuala / augmentata, teleprezenta si telerobotica (Virtual / augmented reality, telepresence, and telerobotics)
- Vehicule autonome (Autonomous vehicles)
- Cartografiere automata, achizitie automata de modele (Automated map making, model acquisition)

Viziunea artificiala

Date de intrare

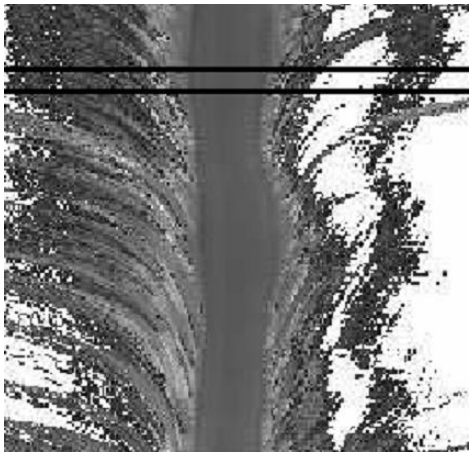
- Imagini captate cu dspozitive de achizitie adaptate pentru intregul spectru frecventa al *undelor eletromagnetice*



Viziunea artificială

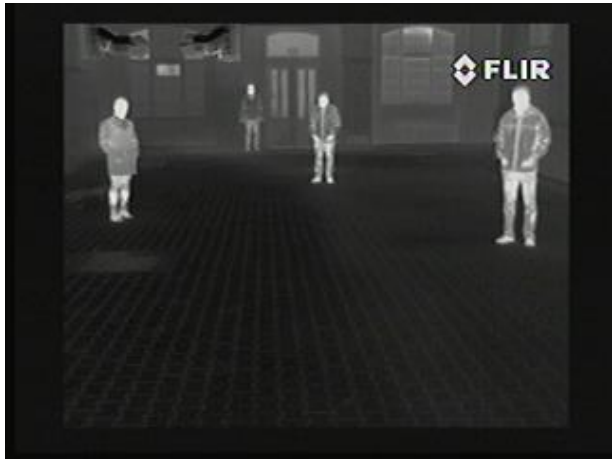
Date de intrare

Spectrul vizibil (380 – 750 nm)

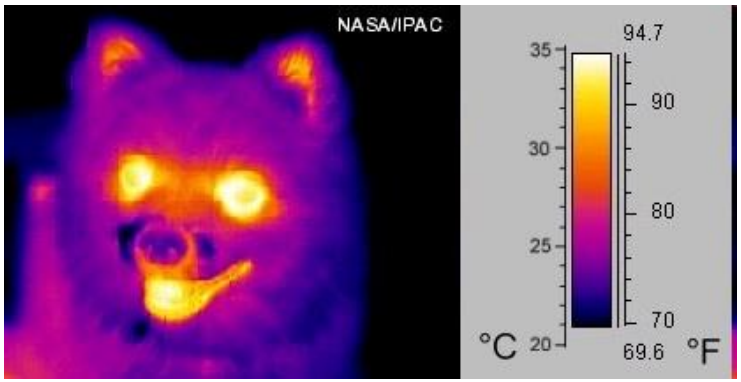


Reflectivitatea LiDAR
(NIR : 0.75 .. 1.4μm)

Reflectivitatea RADAR
24GHz (SRR) / 77 (LRR)



LWIR / Thermal (8-15μm)



LWIR / Thermal (heatmap)

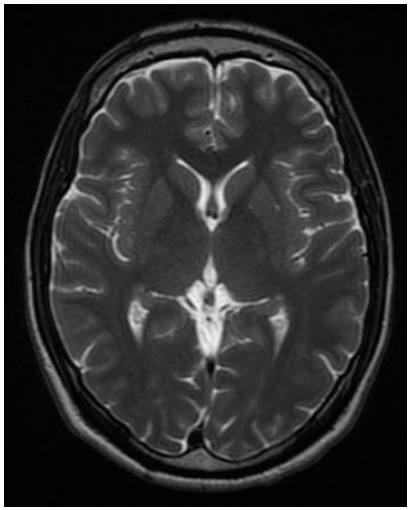
Viziunea artificiala

Date de intrare

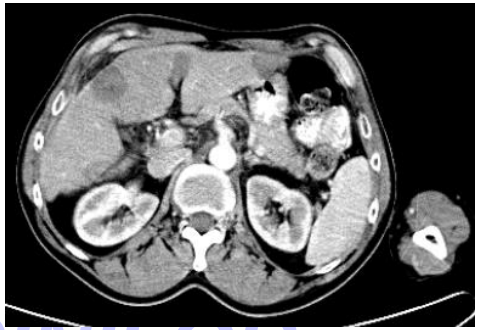
Alte surse de imagini: *unde acustice (US / ecografii), RMN, CT*

US 7–18 MHz: muschi, tiroida, ..
US 1–6 MHz: ficat, rinichi, …

X-ray (radiografie)



MRI (RMN)



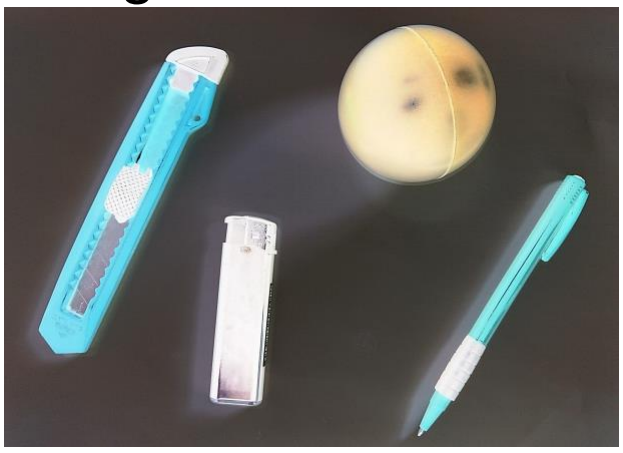
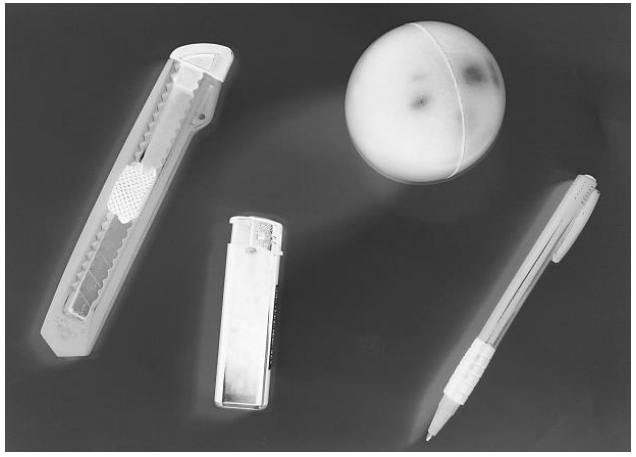
X-ray (CT slice)

Exemple de procesări simple

Conversii Color - Nivele de gri – Imagine binară



Negativ

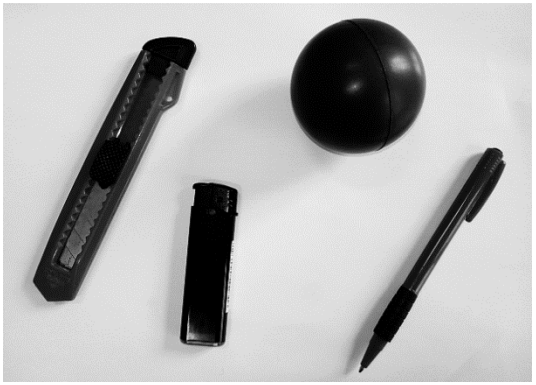




Exemple de procesări simple

Modificare strălucire şi contrast

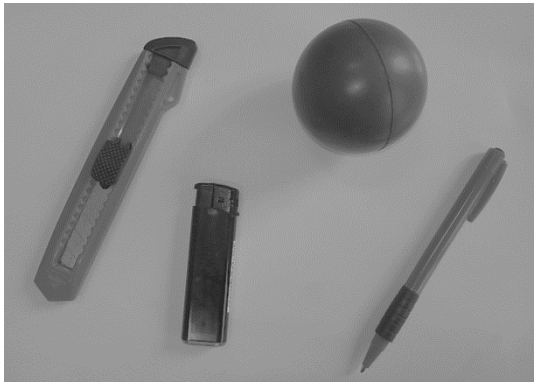
Luminozitate ++

Imaginea sursa



Contrast ++

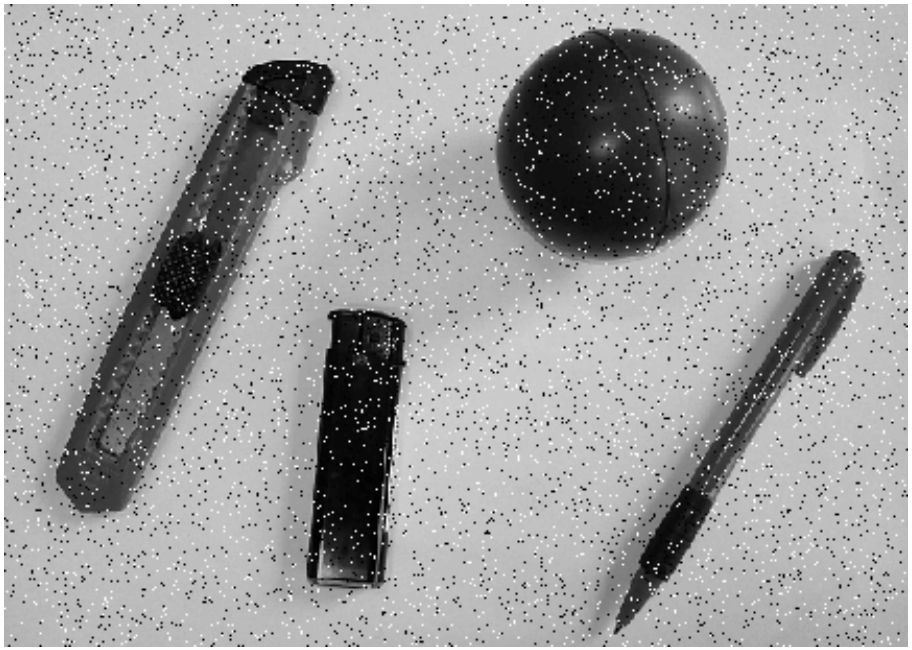
Luminozitate --



Contrast --

Exemple de procesări simple

Eliminarea zgomotului

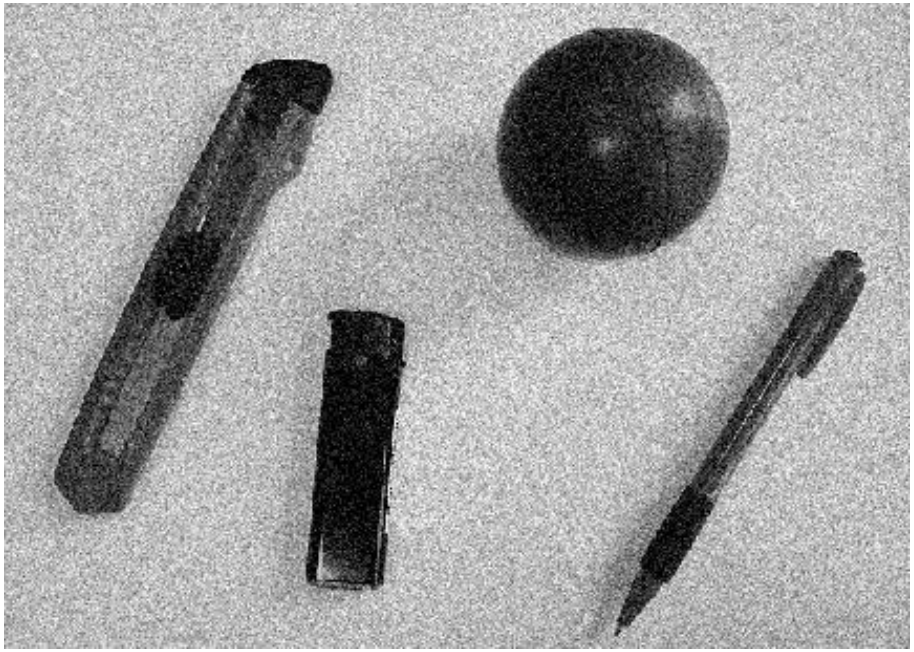


Imagine corupta de zgomot de tip sare şi piper

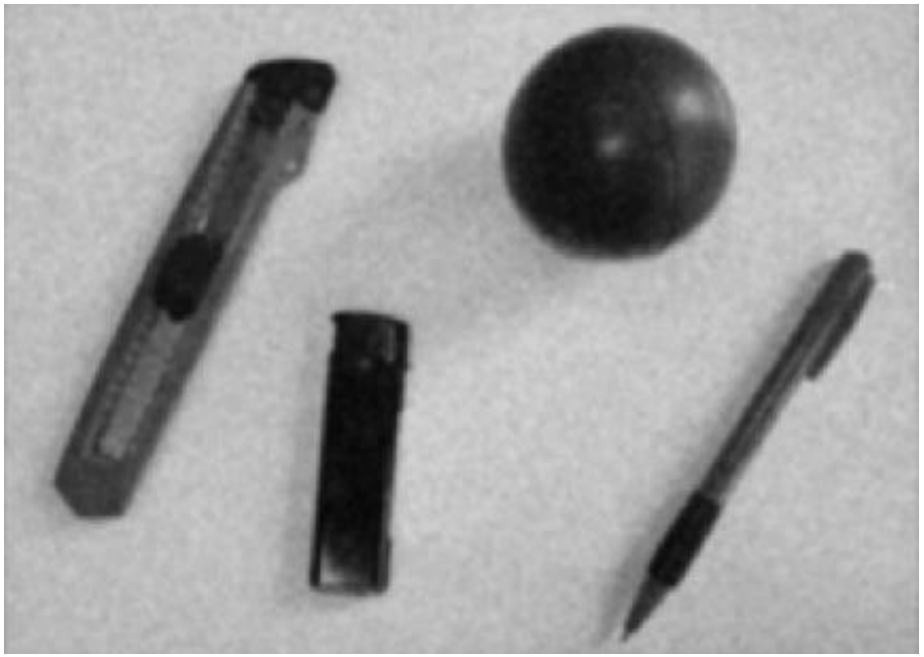
Imagine filtrata: filtru median

Exemple de procesări simple

Eliminarea zgomotului



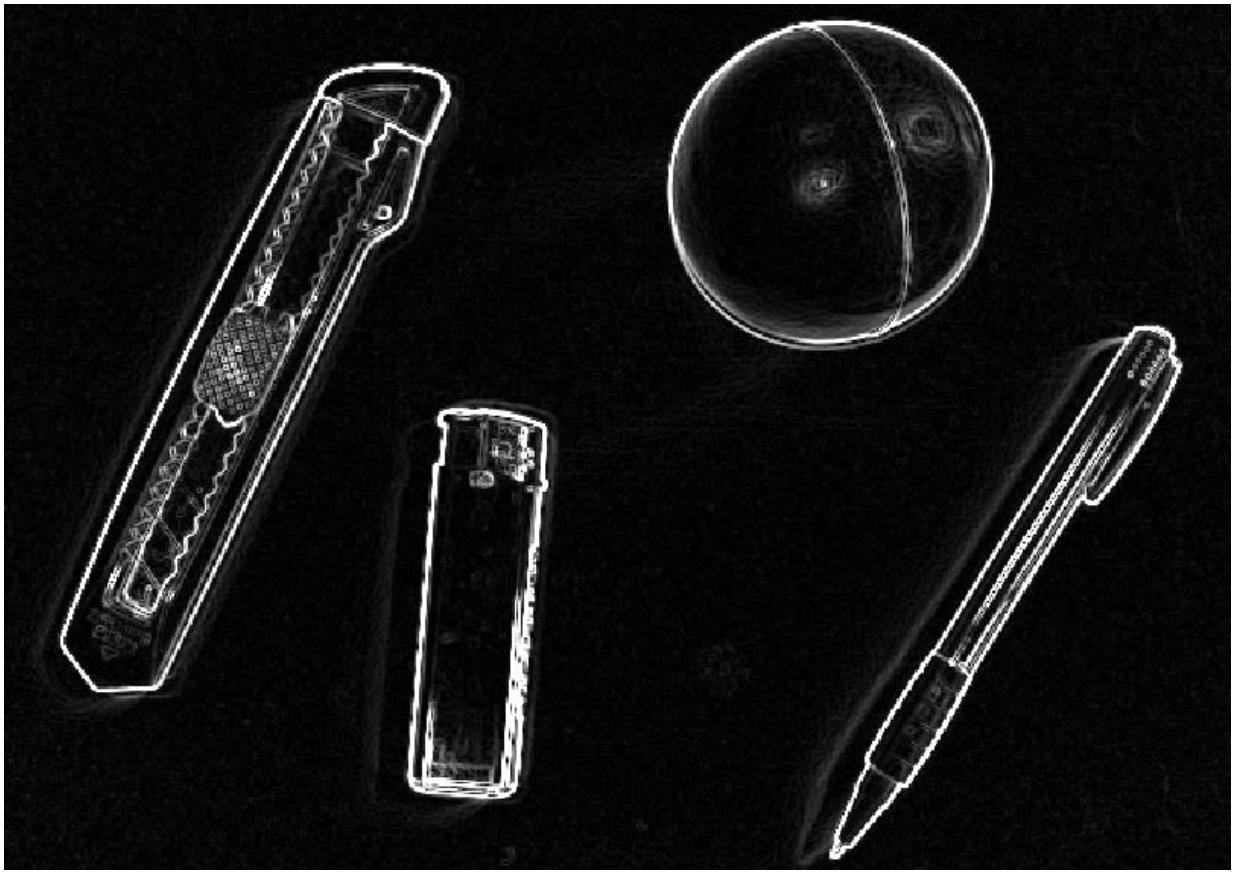
Imagine corupta de Zgomot Gaussian



Imagine filtrata: filtru Gaussian

Exemple de procesări simple

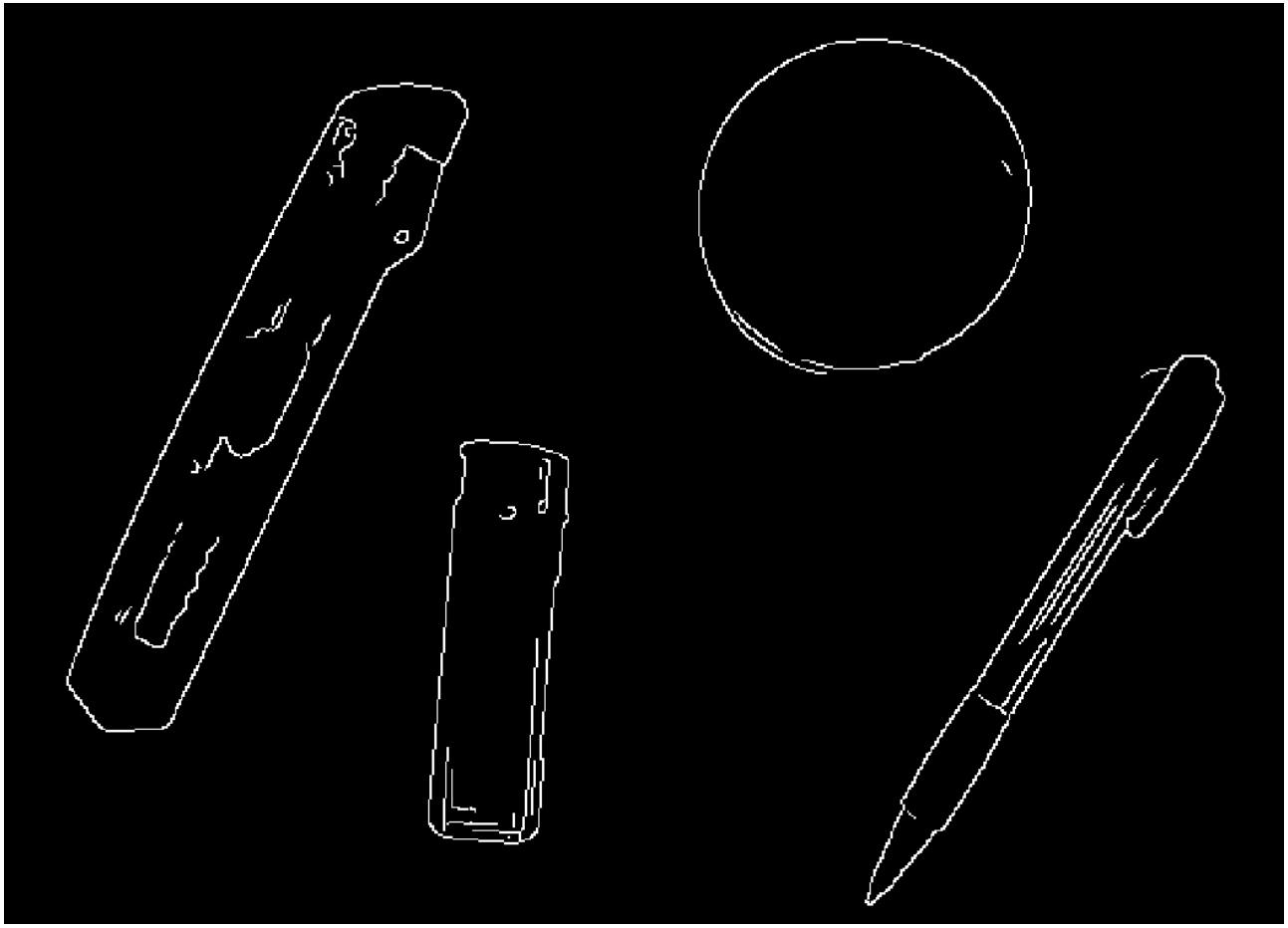
Calculul gradientului – măsura variaţiilor din imagine



Modulul (magnitudinea gradientului)

Exemple de procesări simple

Determinarea punctelor de muchie



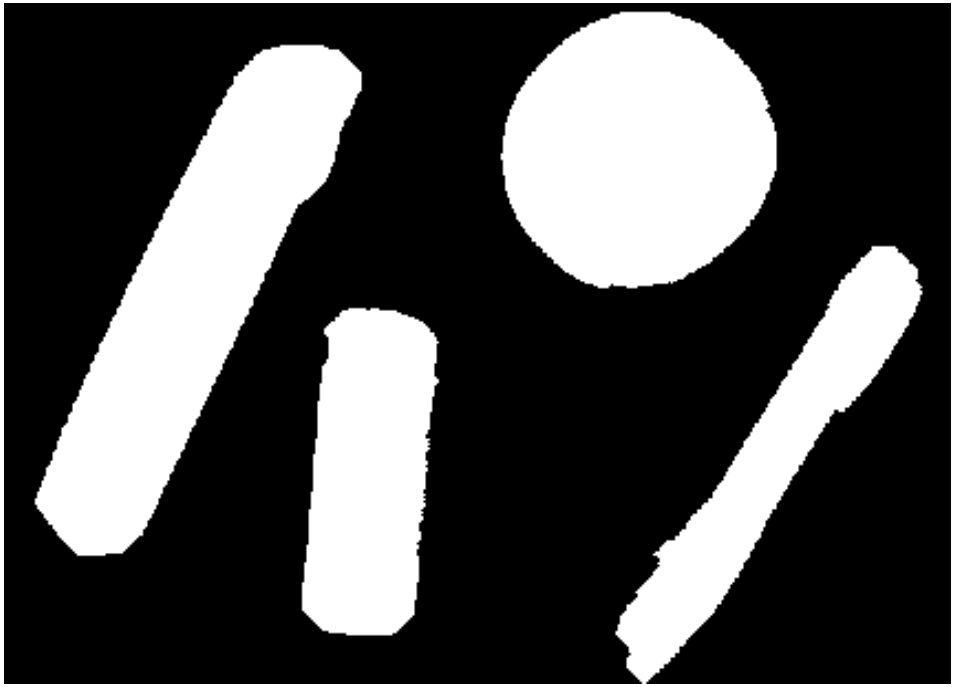
Rezultatul aplicarii alg. Canny (cubtiere + binarizare cu histereza)

Exemple de procesări simple

Operații pe imagini binare - dilatare

Exemple de procesări simple

Operații pe imagini binare - eroziune

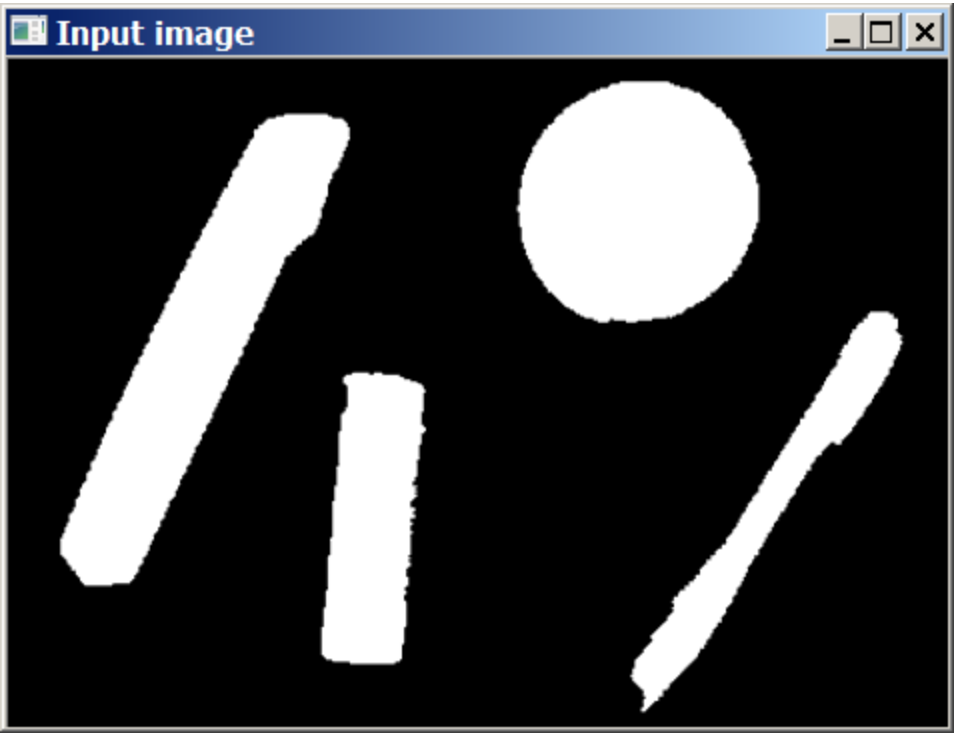


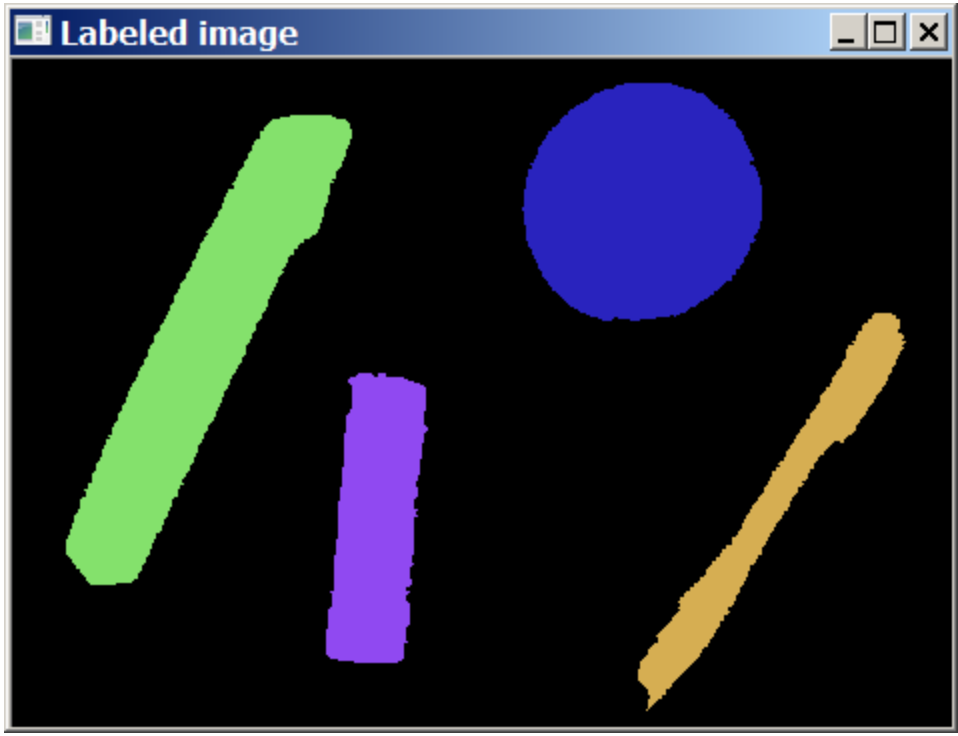
Exemple de procesări simple

Dilatare + eroziune = închidere, umplerea golurilor cu păstrarea conturului exterior neschimbat

Exemple de procesări simple

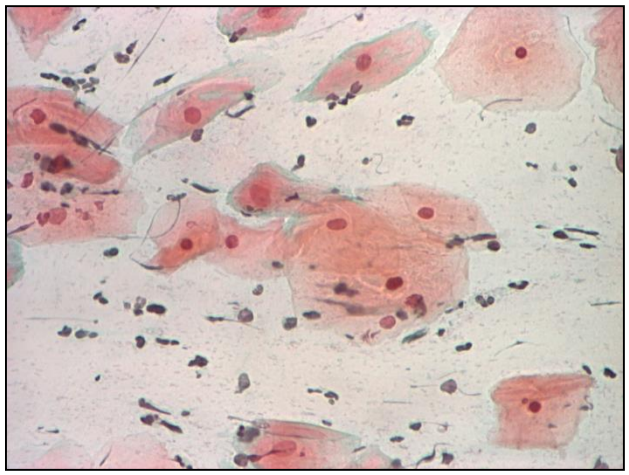
Identificarea obiectelor individuale din imagini binare - etichetarea

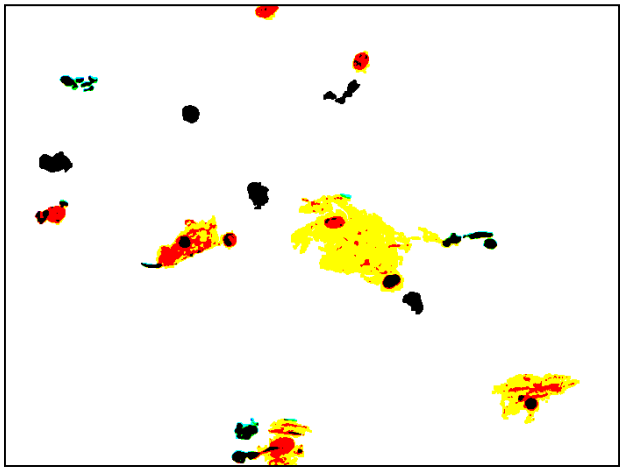


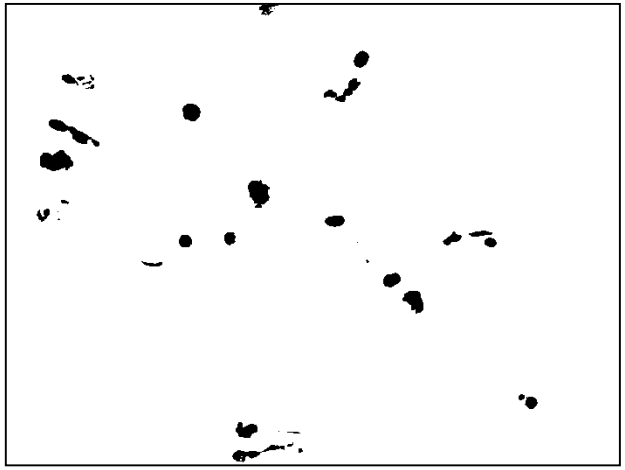


Exemple de procesari complexe

Segmentare si analiza de imagini medicale







Features

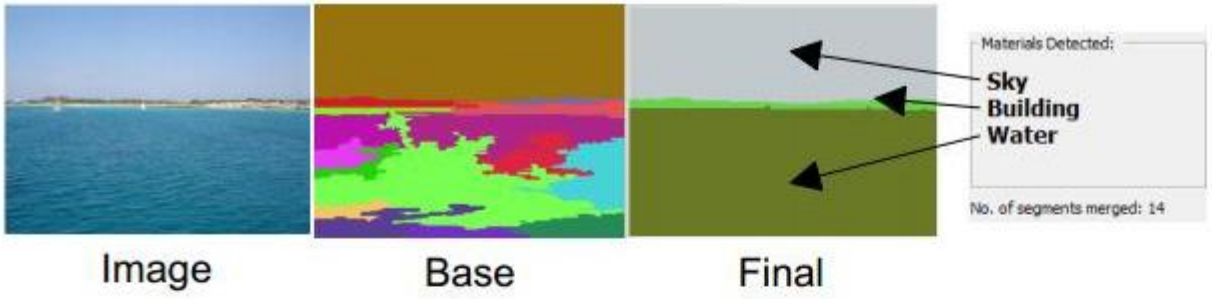
The features extracted from the abnormal nuclei found in the image are:

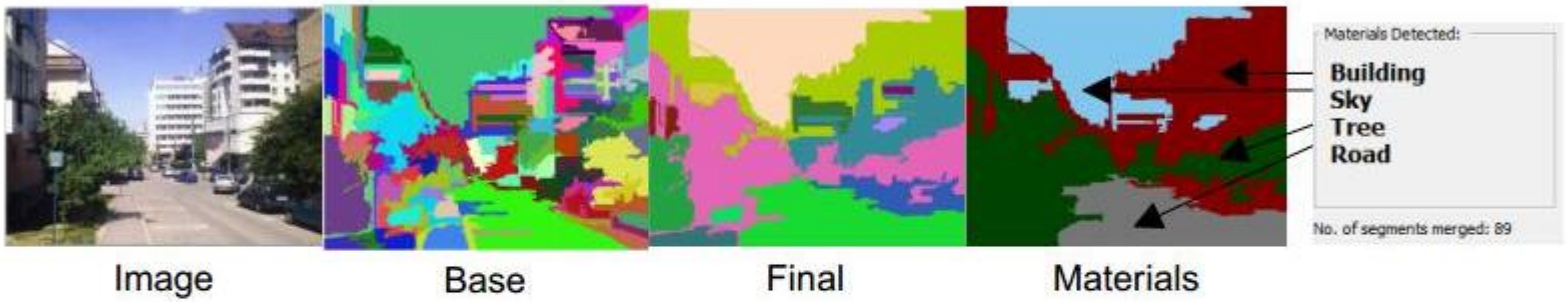
Nucleus	Entropy	Homogeneity	Coarseness	Busyness	Fractal dimension	No. clusters	No. colors
0	2.53647	0.450885	0.0131579	0.661315	1.96163	20	2441
1	2.57566	0.404834	0.0227273	0.611727	4.71926	12	1027
2	2.78164	0.438416	0.013245	0.660755	2.14959	19	2436
3	2.47713	0.454494	0.0168067	0.639943	4.65406	16	1230
4	2.51205	0.435782	0.016	0.644344	2.2737	16	1548
5	2.48444	0.442439	0.018018	0.633624	4.3415	12	1310

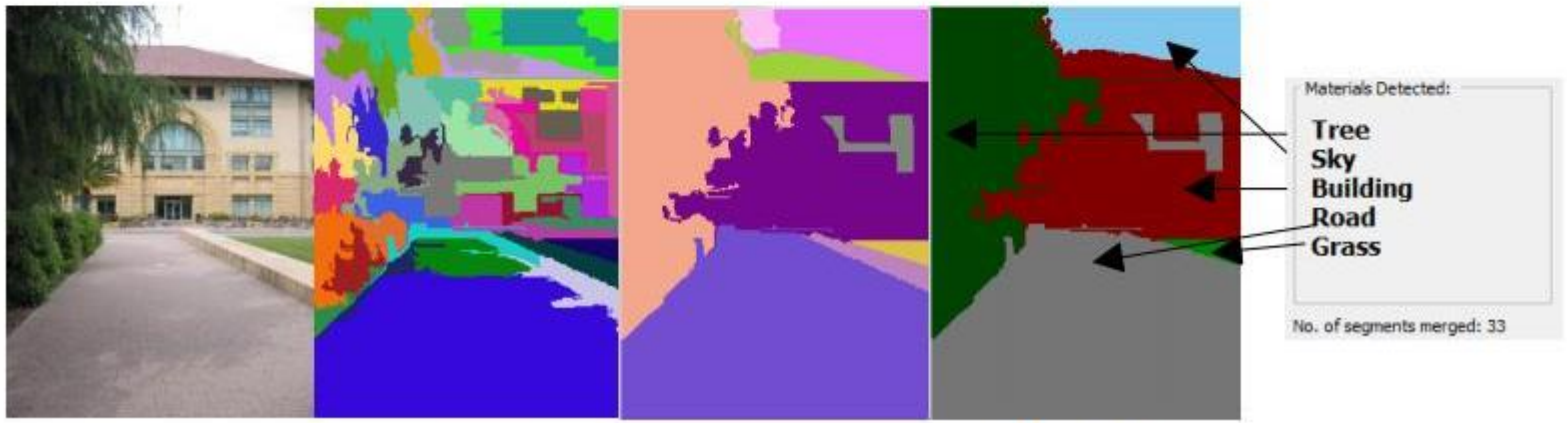
The execution times for the operation mentioned below are:

Operation	Time elapsed
KSW on RGB	00:00:735
KSW and Minimum Error	00:04:422
MultiSpace thresholding	00:02:156
HMT	00:00:390
Texture-related features	00:13:750

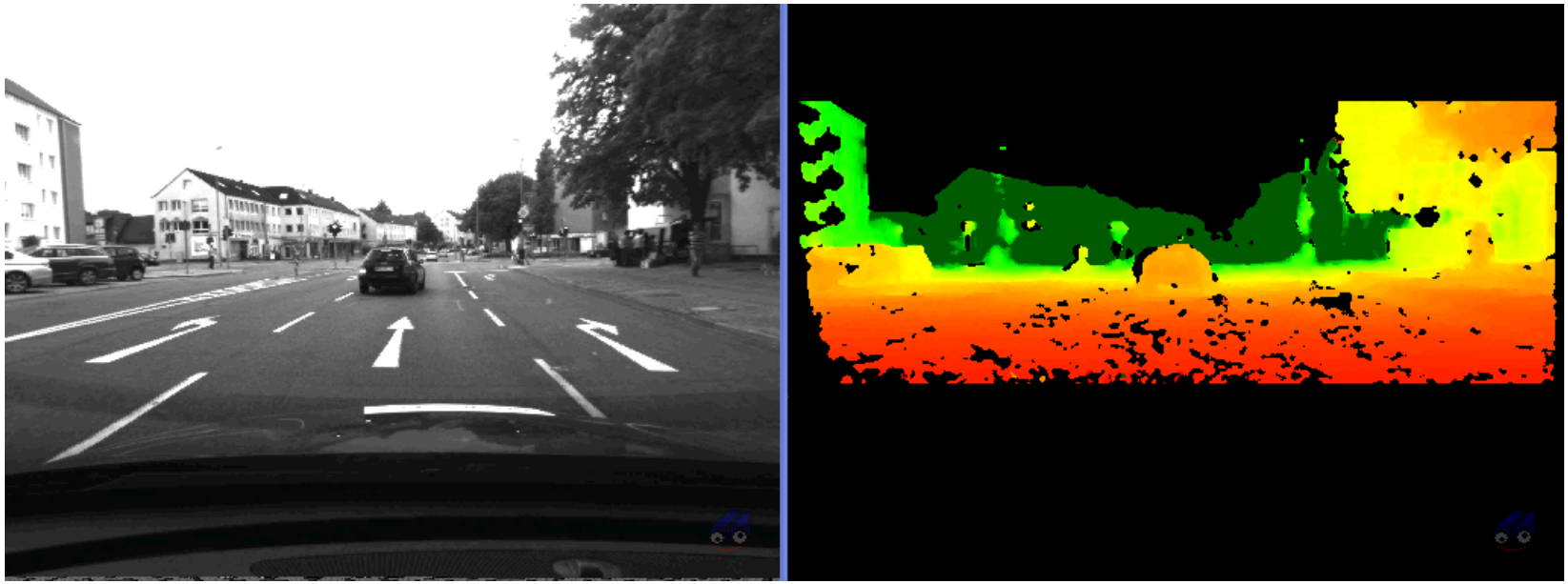
Segmentare imagini







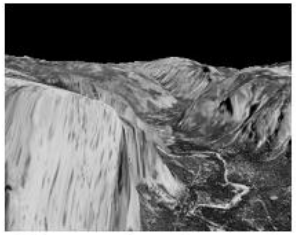
Stereoviziune densa



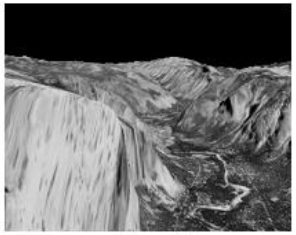
Imagine camera stanga (grayscale)

Harta de adancime

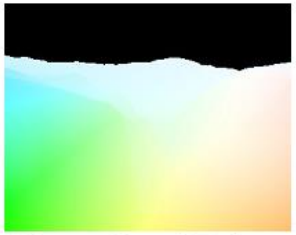
Estimarea fluxului optic



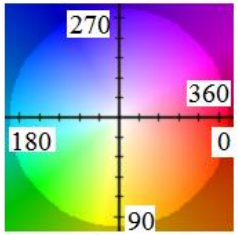
Yosemite frame 0



Yosemite frame 1



Yosemite GT flow

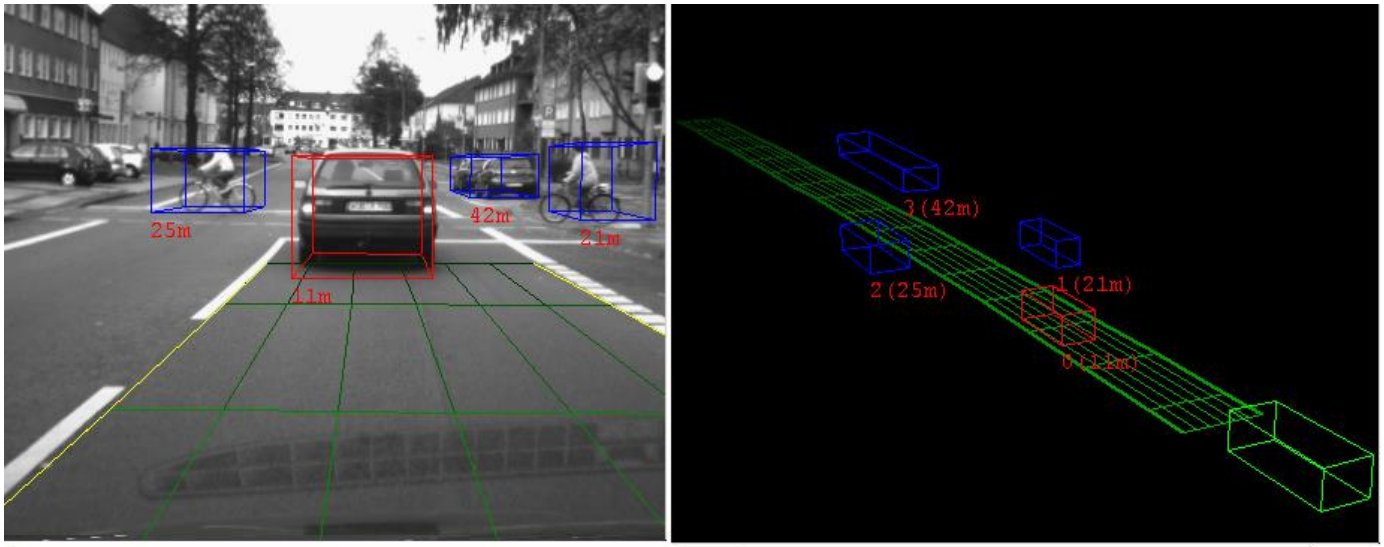


flow color coding

Exemplificare a rezultatului codificarii fluxului de miscare in conformitate cu conventia de culoare Middleburry [4]:
Hue – directia / Saturatia – amplitudinea (similar cu codificarea culorilor in modelul HIS)

Exemple de aplicatii

Detectie obiecte si drum in scenarii de trafic

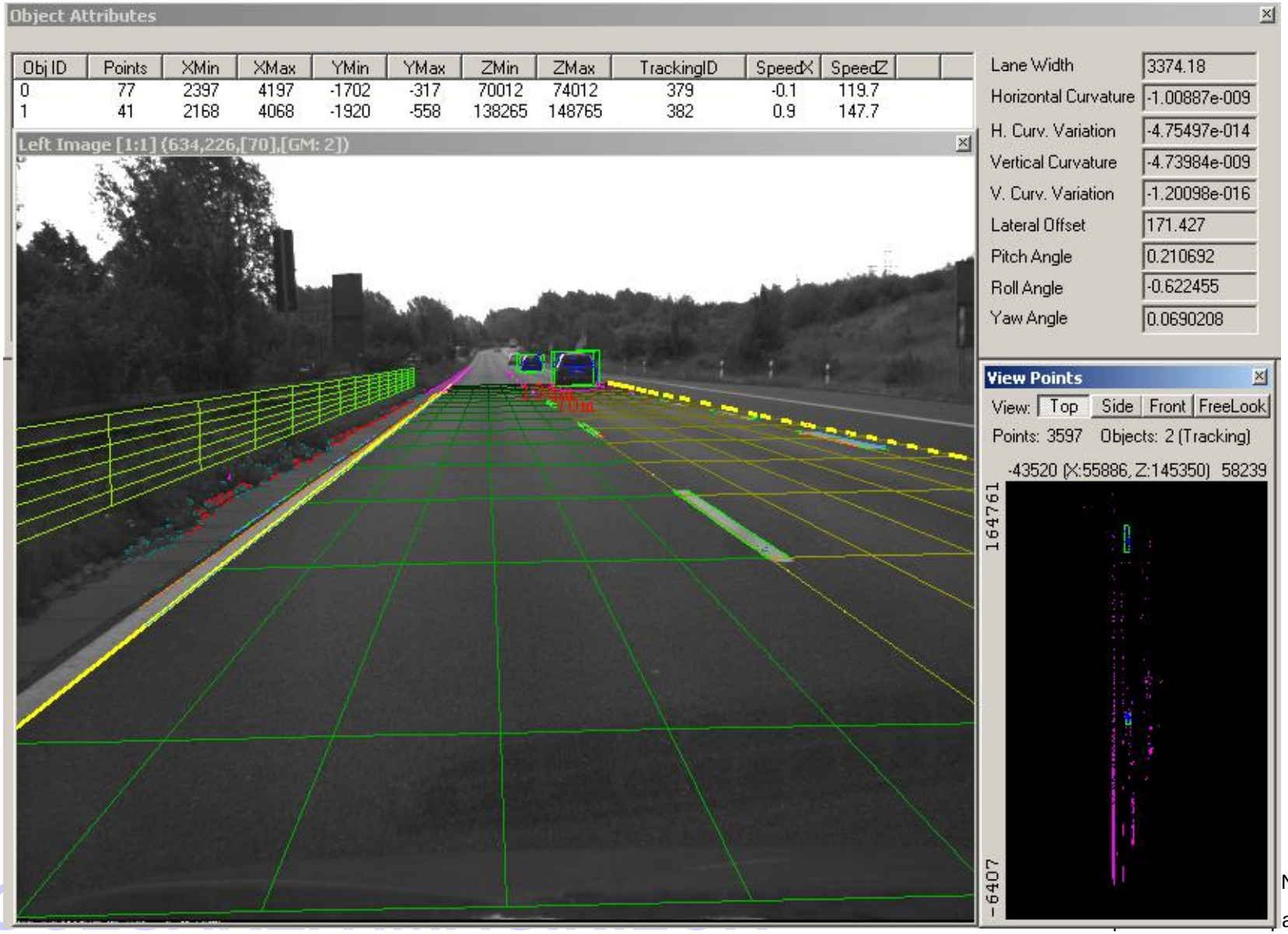


Object Attributes

Obj ID	Points	XMin	XMax	YMin	YMax	ZMin	ZMax	TrackingID	SpeedX	SpeedZ
0	0	-1232	367	-1366	33	11980	15980	1	0.2	-0.9
1	459	3600	5020	-1716	-229	21720	26260			
2	312	-5440	-3340	-1685	-220	25320	30120			
3	366	2940	5420	-1707	-146	42660	56840			

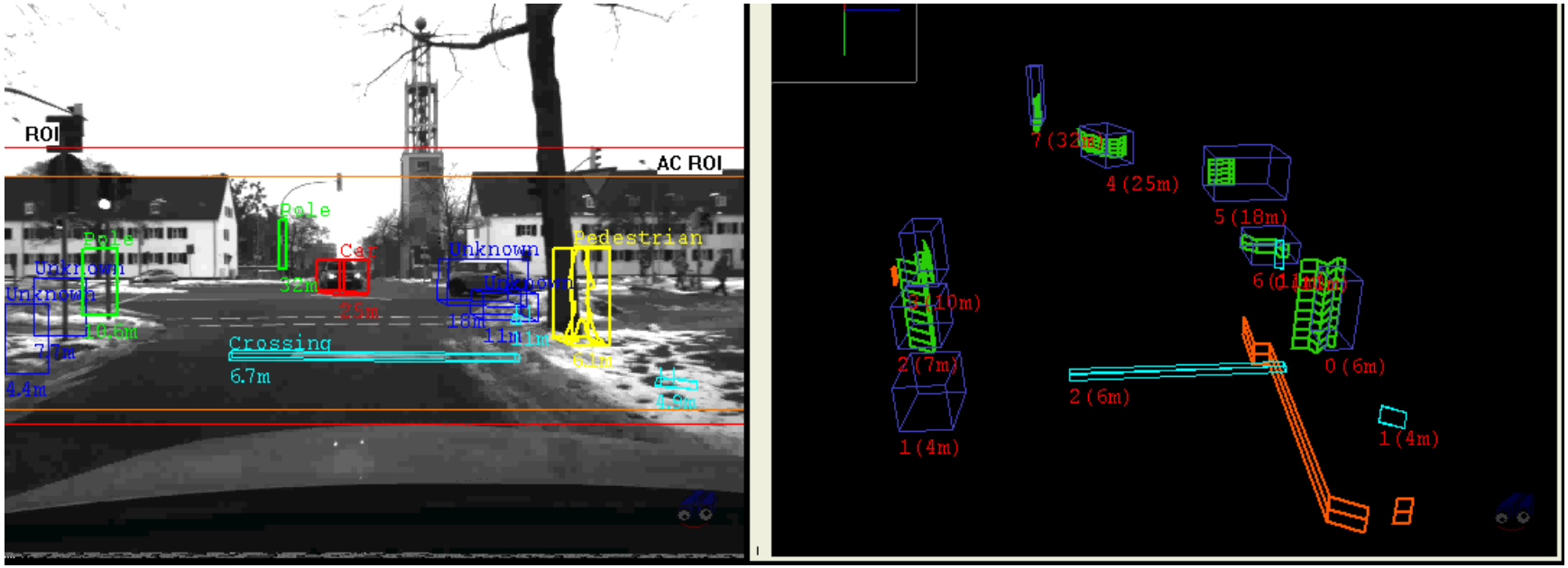
		Units
Lane Width	3548.7	mm
Horizontal Curvature	-8.28237e-007	rad/mm
H. Curv. Variation	0	rad/mm^2
Vertical Curvature	0	rad/mm
V. Curv. Variation	0	rad/mm^2
Lateral Offset	-226.14	mm
Pitch Angle	-0.155341	tan(Ang)
Roll Angle	-0.0736862	tan(Ang)
Yaw Angle	0.466067	tan(Ang)

Exemple de aplicatii



Exemple de aplicatii

Detectie si clasificare obiecte, marcaje de pe drum etc. in scenarii de trafic



Proiecte de cercetare in domeniu

Image Processing and Pattern Recognition Group

http://www.cv.utcluj.ro/research.72.html

Driving Assistance Systems

SCABOR, DESBOR, DESPED, PERSENS: http://www.cv.utcluj.ro/scabor.html

Intrsafe FP7 project: http://www.cv.utcluj.ro/intersafe-2.html

Optical Flow: http://www.cv.utcluj.ro/optical-flow.html

Medical Imaging

http://www.cv.utcluj.ro/tdii.html

http://www.cv.utcluj.ro/focal-liver-diseases.html

http://www.cv.utcluj.ro/adkp-detection.html

Etc. ……

Procesarea imaginilor

Discipline conexe in ani superiori

Licenta

- Sisteme de recunoastere a formelor (an 4 CA)
- Interactiune om-calculator (an 4 TI)

Master

- Viziune Artificiala (an 1 – toate specializarile)
- Viziune Artificiala pentru roboti mobili (an 2 – IVA)
- Interfete om-calculator (an 2 – IC)