Technical University of Cluj - Napoca
Computer Science Department

Interactiune Om-Calculator

Curs 10

Detectie prezenta. Detectie persoane.

Aplicatii

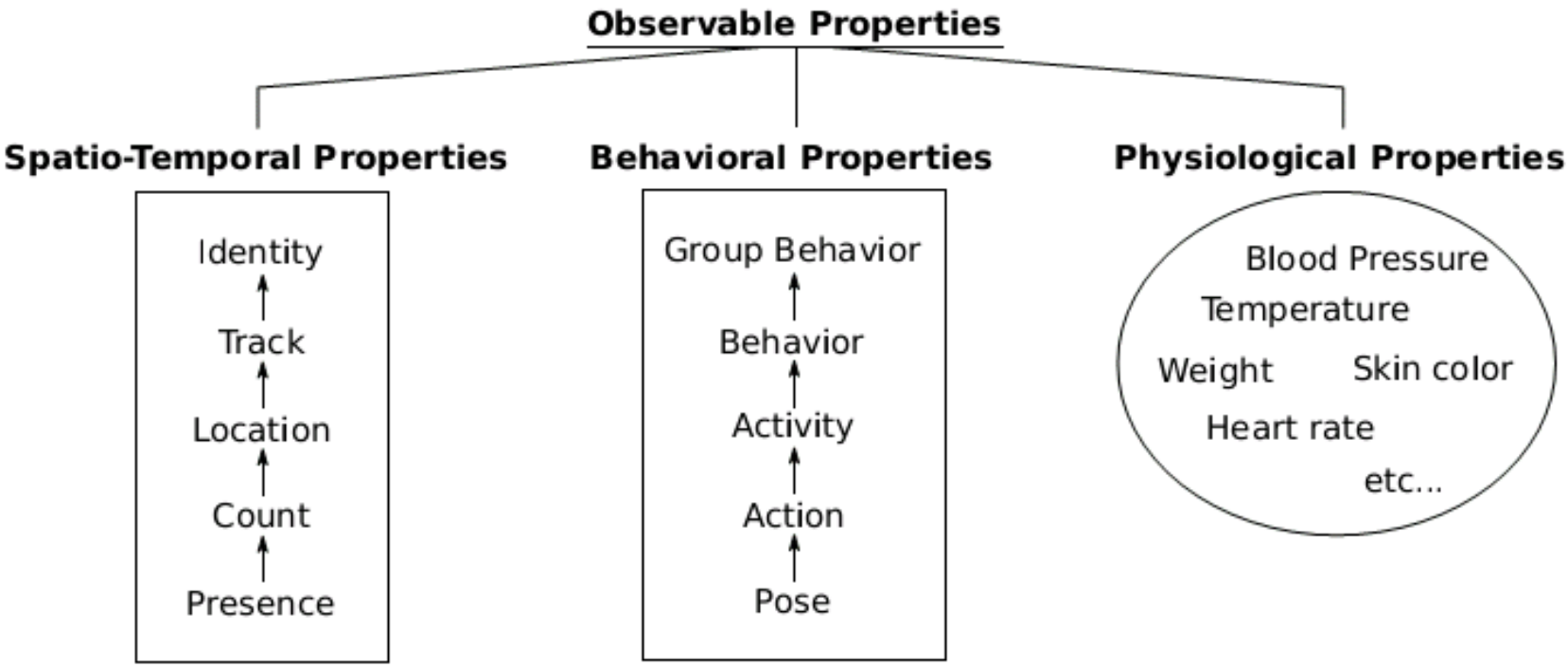
Detectie prezenta

Detectie prezenta, locatie, numar, identitate ….

[1] A Survey of Human-Sensing: Methods for Detecting Presence, Count, Location, Track, and Identity, T.TEIXEIRA, G. DUBLON, A. SAVVIDES, Yale University / Massachusetts Institute of Technology, http://www.eng.yale.edu/enalab/publications/human_sensing_enalabWIP.pdf (lectura obligatorie) sau in C10-extra

Detectie prezenta

Proprietati observabile [1]



Detectie prezenta

Proprietati spatio-temporale [1]

1. Prezenta – exista cel putin o persoana ?
    - senzori de miscare: PIR, viziune (BS, segm./clasif.)
    - senzori de proximitate: IR range finder
    - RFID
2. Numar – cate persoane ?
    - numaratoare/counters (bariera IR / mecanica)
    - viziune: camere (vizibil, IR, termale)
3. Localizare – unde ?
    - senzori GPS (outdoor)
    - IR range finder, viziune (monoculara sau stereo)

Detectie prezenta

Glosar

PIR (Passive InfraRed Sensor/Detector): masoara variatii in radiatia IR detectata $\Rightarrow$ “senzori de miscare”

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

RFID (Radio Frequency Identification): transfer de informatii stocate intr-un Tag.

Tag-urile sunt in general passive (passive transponder) si se alimentaza prin inductie electromagnetica generata de un camp electromagnetic apropiat.

Cele cu sursa proprie pot fi interogate de la distanta (sute metri) si transmit periodic semnal.

https://en.wikipedia.org/wiki/Radio-frequency_identification

AIDC (Automatic identification and Data Capture): metode pentru identificarea automata a obiectelor si achizitia de date/informatii – coduri de bare, RFID, biometrica, OCR, recunoastere de voce, smart cards

Detectie prezenta

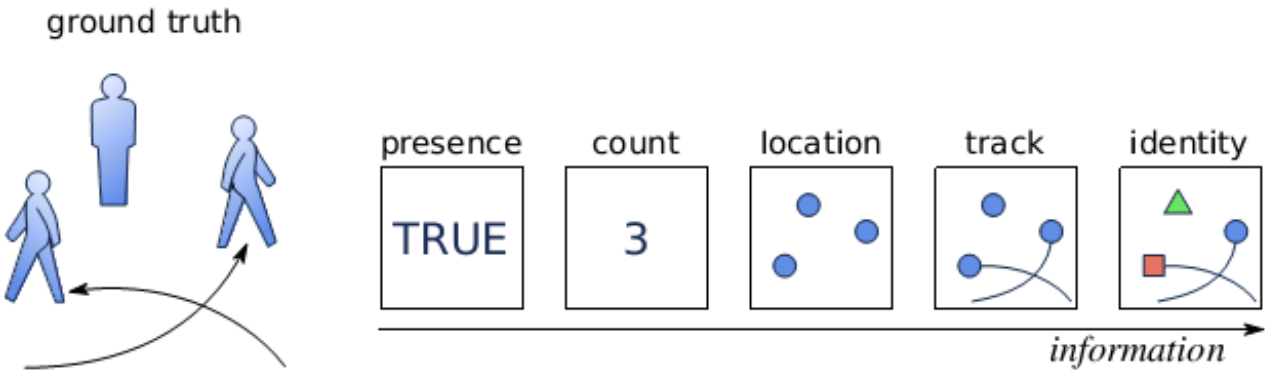
Proprietati spatio-temporale [1]

4. Urmarire (track) – unde se afla perosana inainte ? (si predictia pozitiei viitoare)

- inferarea identitatii relative

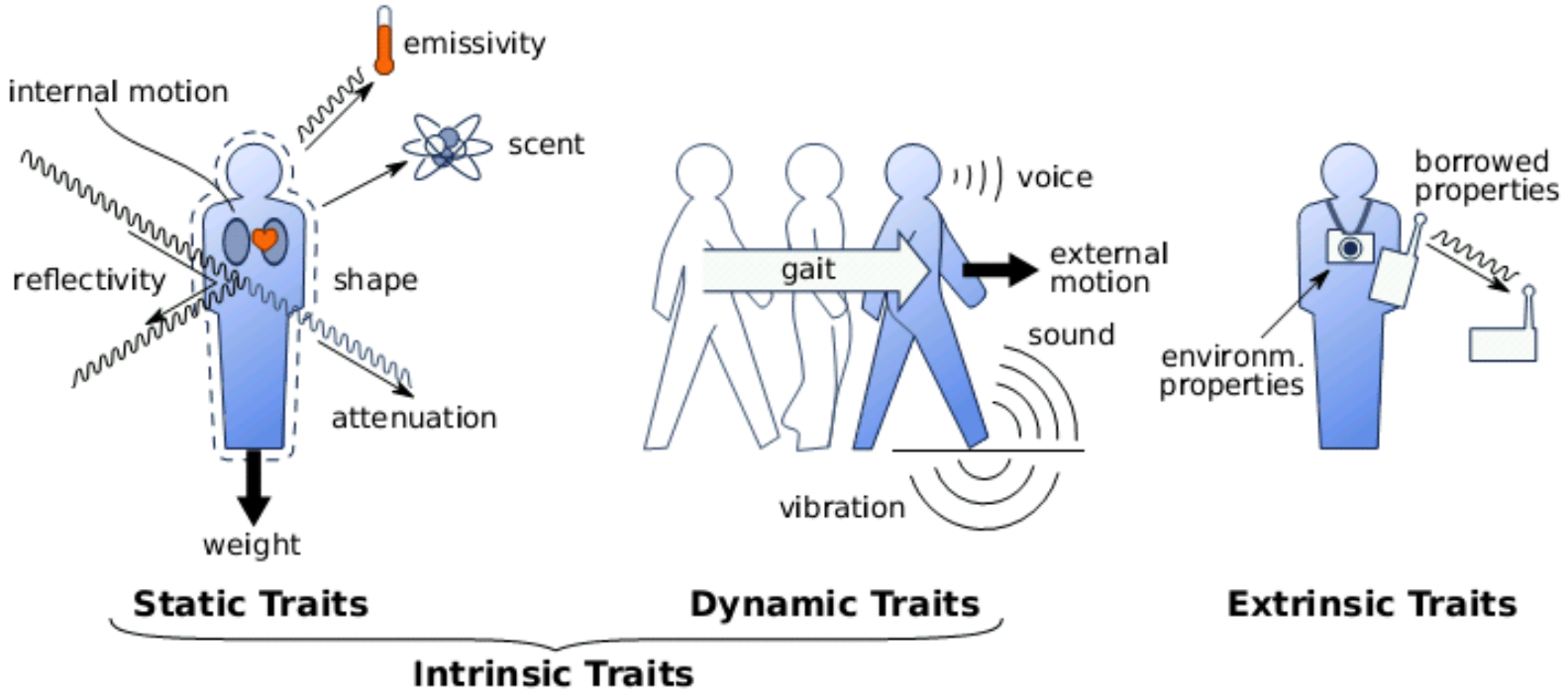
5. Identitate – cine este persoana ?

- inferarea identitatii absolute



Detectie prezenta

Trasaturi [1]

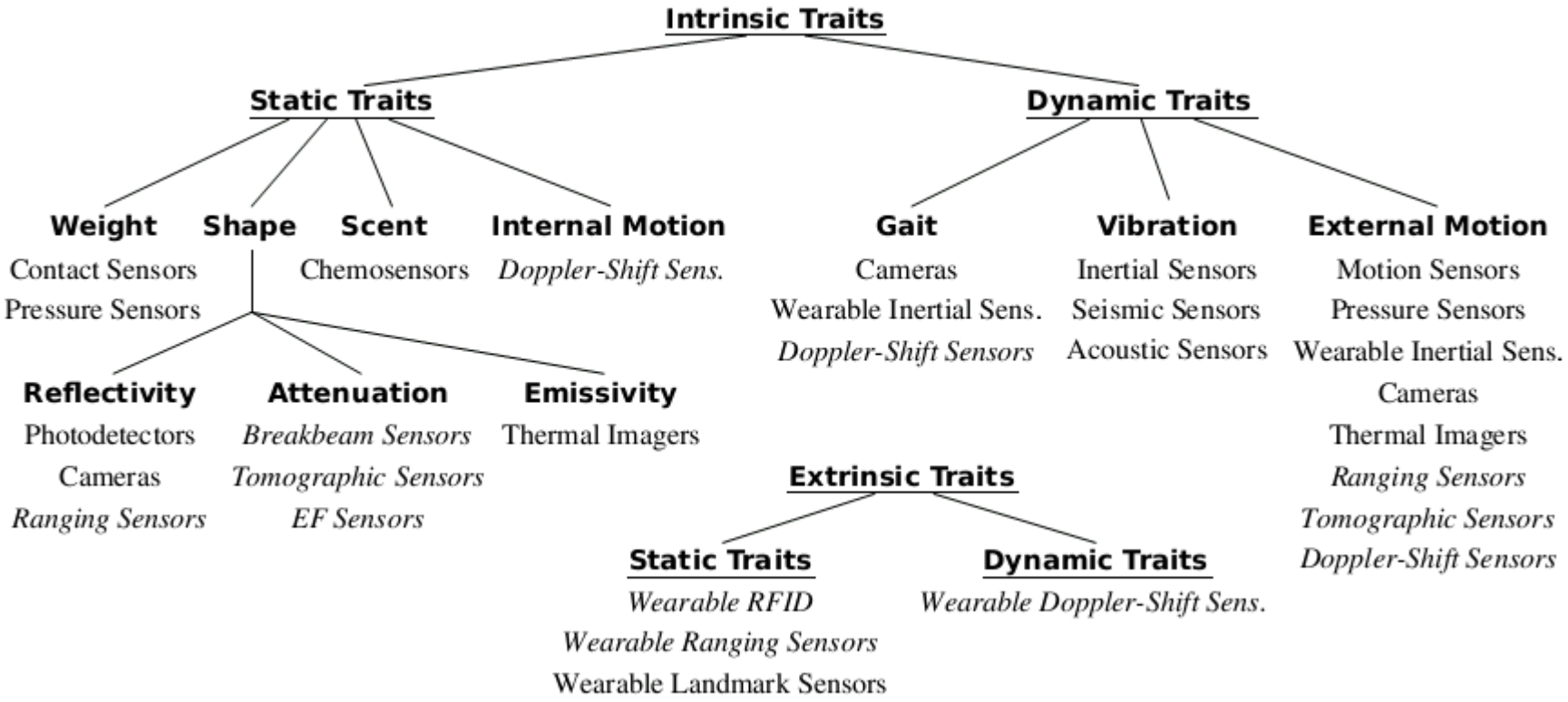


Detectie prezenta

Clasificarea trasaturilor (umane)

Intrinseci – caracterstici anatomo-fiziologice

Extrinseci – obiecte exterioare purtate de o persoana



Detectie prezenta

Senzori [1]

Setup:

- instrumentat (persoana poarta un dispozitiv (ex. RFID)
- neinstrumentat

Natura:

- activi (laser scanner, camere NearIR)
- pasivi (camere vizibil, FarIR (LWIR /termale))

Densitatea retelei de senzori:

- singulari / retea
- ex: 1 camera viziune $\Rightarrow \log_2(1)=0$

36 senzori de presiune in podea $\Rightarrow \log_2(36)=5.17$

Detectie prezenta

Senzori neinstrumentati [1]

1. Binari (output = 1 sau 0) ⇒ detectie prezenta / proximitate

- bariere optice, senzori de contact (presiune), PIR, senzori EF (Electric Field), IR / capacitivi (smartphone)

2. Senzori de vibratie si acustici pasivi ⇒ detectie prezenta

⇒ alarme auto si de locuinte

3. Unde radio, US, laser (activi)
- radar (radio waves), sonar (sound or ultrasound), lidar (laser) ⇒ imagine 2D/3D ⇒ prezenta si localizare
- Doppler-Shift ⇒ prezenta si viteza (detectie miscare)
- tomografie RF ⇒ detectie, numarare, localizare, urmarire

Detectie prezenta

Glosar

Doppler-Shift (effect Dopller) – schimbarea frecventei unei unde in functie de miscarea relativa dintre observator si sursa de radiatie a undei (spre sau dinspre sursa de radiatie)

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

Exemplu: detectie de miscare pe baza undelor acustice

https://danielrapp.github.io/doppler/

LIDAR – scanner laser cu (1 sau mai multe raze)

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

https://velodynelidar.com/products/

https://www.youtube.com/watch?v=75yJUW91lTs

https://www.youtube.com/watch?v=nXlqv_k4P8Q

Detectie prezenta

Senzori neinstrumentati [1]

4. Senzori de viziune (camere)

- Rezolutie superioara, info. de culoare, textura, forma

$\Rightarrow$ prezenta, localizare, urmarire, numarare, identificare

- Viziune monoculara

    - BS (background subtraction) – fundal/camra fixe

    - segmentare obiecte si recunoastere de forme

- Camere de profunzime:

    - stereoviziune

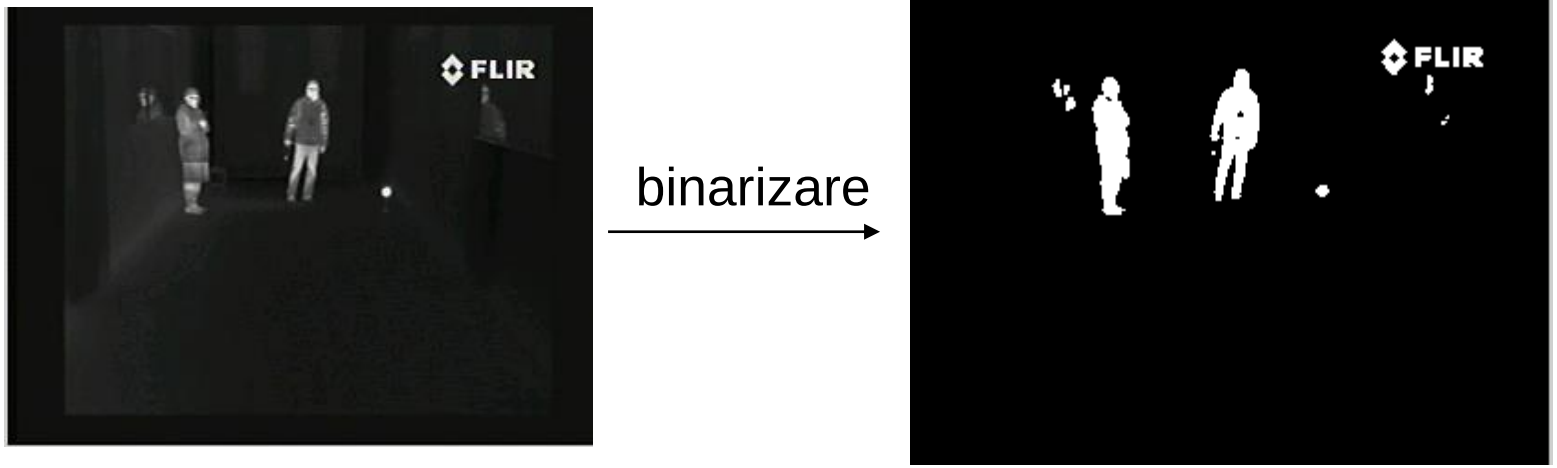
    - camere de profunzime (lumina activa): Kinect, Intel RealSense (Creative)

Detectie prezenta

Senzori neinstrumentati

Camere termale (Far IR: $\lambda \sim 9 .. 14\ \mu m$)

- https://en.wikipedia.org/wiki/Thermographic_camera
- http://www.flir.eu/home/, https://www.youtube.com/watch?v=J0EDwwl3bZ4
- https://www.youtube.com/watch?v=RDvruAQjM58
- https://www.youtube.com/watch?v=kGPXbomnSYk



Detectie prezenta

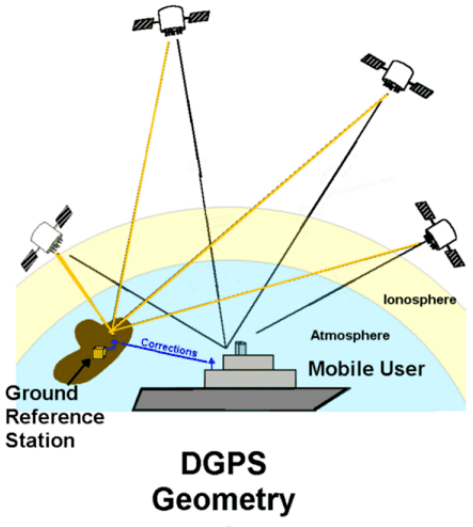
Senzori instrumentati unimodali [1]

Dispozitive purtate de persoana respectiva

⇒ prezenta, localizare, urmarire, numarare, identificare cu precizie foarte buna

1. Device-to-Device Ranging
   - GPS (ε ~ 10 m) / DGPS (ε ~ 10 cm)
   - RFID (sensibili la zgomote EM)

2. Recunoastere a mediului
   - radio signal strength fingerprint-ing



⇒ compararea unei harti cunoscute a semnalului cu o amprenta instantanee (WiFi ε ~1.5 cm) / GSM ε ~ m)

Detectie prezenta

Senzori instrumentati unimodali [1]

Dispozitive purtate de persoana respectiva

3. Dead-reckoning (drum estimat)

- Estimarea caii de deplasare cu senzori inertiali (viteza / aceleratie: robotica ~ odometrie)

- Senzori: inertial measurement units (IMUs)
    - accelerometre (acceleration sensors)
    - giroscoape (angular velocity sensors)
    - magnetometers (magnetic feld sensors: E-compass)

Erorile de localizare:
    - se acumuleaza in timp $\Rightarrow$ corectii
    - solutii: IMU plasat in pantof (zero-velocity updates)
    $\Rightarrow$ erori de localizare 3D 2% (err. 2m la 100m)
    ZUPT + EKF ~ 0.2% eroare

Senzori individuali – sinteza [1]

sensing modalities	signaling	presence	count	location	track	identity	ND
Uninstrumented							
Contact Sensors	passive	◯	o	o	o		4
Pressure Sensors	passive	◯	o	o	o	·	4
Chemosensors	passive	–	–	–	–	–	?
Photodetectors	passive	·	·	·	·		4
Cameras	either	◯	◯	◯	◯	o	0
Thermal Imagers	passive	◯	◯	◯	o	·	0
Breakbeam Sensors	active	o	–	–	–		4
Scalar Range-Finders	active	o	–	–	–		0
Scanning Range-Finders	active	o	o	◯	o	·	0
Tomographic Sensors	active	◯	o	o	o	–	5
EF Sensors	active	◯	o	o	o		4
Doppler-Shift Sensors	active	o	o	o	o	·	0
Motion Sensors	either	o	·	·	·		2
Seismic and Inertial Sensors	passive	o	·	·	·		3
Microphones	passive	o	·	·	·	·	1
Instrumented							
Wearable Inertial Sensors	passive	ϟ	ϟ	ϟ	ϟ	ϟ	×
Wearable Environment Recognition	passive	ϟ	ϟ	ϟ	ϟ	ϟ	×
Wearable SS Device-to-Device Rangers	either	◯	◯	·	◯	◯	2
Wearable AA Device-to-Device Rangers	active	◯	◯	o	◯	◯	2
Wearable TOA/TDOA Dev.-to-Dev. Rang.	active	◯	◯	◯	◯	◯	2
Wearable Doppler-Shift Sensors	active	◯	◯	o	◯	◯	2

◯ = good performance o = medium performance · = low performance
– = plausible, but no detailed literature ? = no literature
ϟ = requires communications (i.e. depends on the addition of a radio)
× = not applicable: this is solely a self-sensing method, so no network is involved.

Detectie prezenta

Abordari bazate pe fuziune senzoriala [1]

Senzori multipli:

- combinarea avantajelor individuale

- minimizarea dezavantajelor individuale

1. Camera + microfoane

Ex: sistem automat pt. video–conferinta: urmarirea si localizarea vorbitorului (camere montata pe disp pan-tilt-zoom + arie de microfoane)

2. Camera + Laser Range-Finder

Ex: roboti care detceteaza persoane – localizare cu LiDAR + rafinare cu recunoastere de fete)

Detectie prezenta

Abordari bazate pe fuziune senzoriala [1]

3. Dead-Reckoning & Device-to-Device Ranging

Ex: senzor inertial + GPS + filtrare (Kalman sau particle filter)
$\Rightarrow$ eroare medie de 2m (+ utilizarea unei harti: 1.2m)

4. Dead Reckoning & Environment Recognition with Wearable Camera

Ex: WIMU +HMC (head Mounted Camera)

5. Infrastructure Cameras & Wearable IMU (WIMU)

- Retea de camere: detectia si localizarea persoanelor

- WIMU – localizare (potrivirea acceleratiei video ~ WIMU)

- Precizie de 90%

Detectie prezenta

Abordari bazate pe fuziune senzoriala [1]

6. Laser Range-Finders & ID badges

Ex: detectia, numararea, localizarea, urmarirea si identificarea persoanelor in birouri

- ID badges active (IR & US)

7. Camera and RFID

Ex. Urmarirea unei persoane intr-un mediu aglomerat

- Robot cu o camera si un cititor RFID (matrice de 10 antene orientate radial)

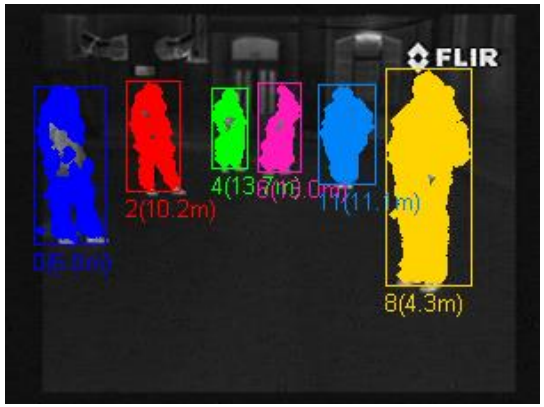
- Imbunatatire a preciziei : 21% (camera) $\Rightarrow$ 86 % (RFID)

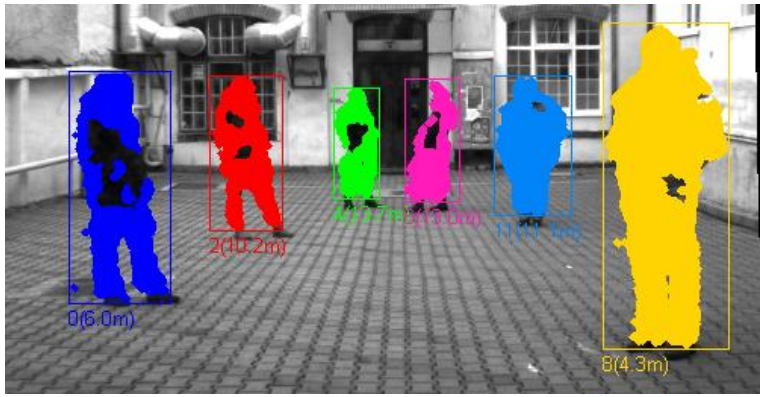
Detectie prezenta

Abordari bazate pe fuziune senzoriala

Fuziune camera termala (Far IR) + sensor de stereoviziune

Fuziune cu sensor stereo





Fuziune senzoriala – sinteza [1]

sensor fusion approaches	signaling	presence	count	location	track	identity	ND
Uninstrumented							
Camera & Microphones	passive	◯	◯	◯	∘		0
Camera & Laser Range-Finder	active	◯	◯	◯	∘		0
Instrumented							
Dead-Reck. & Dev.-to-Dev. Ranging	active			ϟ	ϟ	ϟ	×
Dead-Reck. & Env. Recog. w. Wear. Cam.	active			ϟ	ϟ	ϟ	×
Infrastructure Cameras & Wearable IMU	passive	◯	◯	◯	ϟ	ϟ	0
Laser Range-Finders & Wearable ID Badges	active	◯	◯	◯	◯	◯	2
Camera & RFID	active	∘	∘	∘	∘	◯	0

◯ = good performance ∘ = medium performance · = low performance
ϟ = requires communications (e.g. self-localization followed by broadcasting)
× = not applicable: this is solely a self-sensing method, so no network is involved.

Detectie persoane prin VA

Detectia de persoane

- Camera monoculara / stereo / termala (senzor pasiv)

Model de detectie:

1. Segmentare
2. Extragere de trasaturi
3. Clasificare

Localizare

- Masuratori monoculare sau stereo:
http://users.utcluj.ro/~tmarita/IPL/IPCurs/C11.pdf

Urmarire

- Trasaturi individuale sau obiecte (vezi cursurile si laboratoarele IOC)

Detectie identitate

- Recunoastere fete sau sablon de pasire (mers)

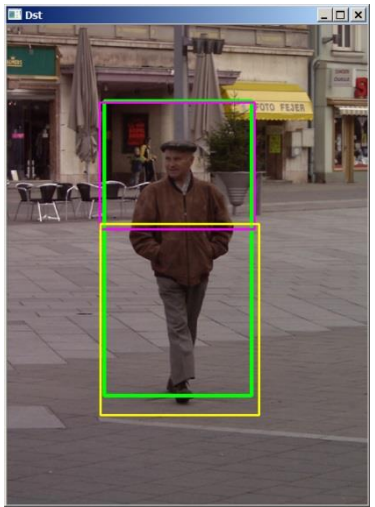
Detectie persoane

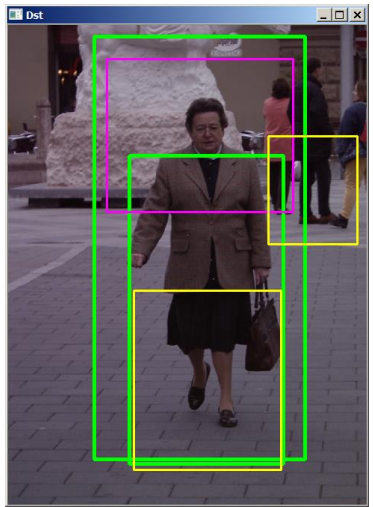
Trasaturi Haar

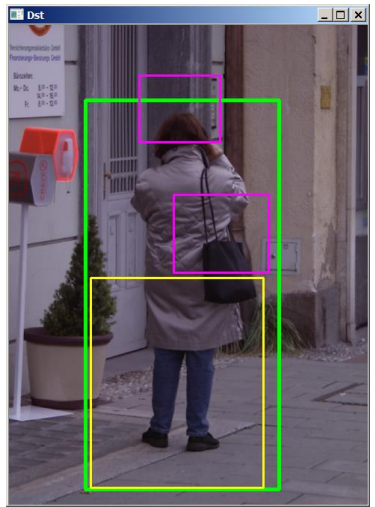
- trasaturi de tip Haar calculate pe sub-regiuni din imagine folosind imaginea integrala (vezi cursul 7-8),
- identificarea prezentei persoanelor sau a unor parti ale corpului uman cu un clasificator de tip cascada.

Modelele clasificatorilor cascada bazati pe trasaturi Haar pentru detectia de persoane: *%OPENCV_DIR%\data\haarcascades* si sunt urmatorii:

haarcascade_fullbody.xml
haarcascade_lowerbody.xml
haarcascade_upperbody.xml







Detectie persoane

Trasaturi HOG
https://www.learnopencv.com/histogram-of-oriented-gradients/ ,

Lectura optionala:
1. Histograms of oriented gradients for human detection, N. Dalal, B. Triggs, Proceedings of the 2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'05) - Volume 1, pp. 886-893. http://lear.inrialpes.fr/people/triggs/pubs/Dalal-cvpr05.pdf
2. Human Detection Using Oriented Histograms of Flow and Appearance, N. Dalal, B. Triggs, C. Schmid, GRAVIR-INRIA
3. Human Detection in RGB Images, I. Rishabh, Arjun Satish, University of California, Irvine,

OpenCV - Detectie descriptori HOG (gpu):
http://docs.opencv.org/modules/gpu/doc/object_detection.html

Model clasificator (casacda): hogcascade_pedestrians.xml

Aplicatii - Detectie de pietoni

Lectura optionala:

Sisteme ADAS (Advanced Driving Assistance Aystems)

http://www.gavrila.net/Media_Coverage/Intelligent_Drive/intelligent_drive.html

http://www.gavrila.net/Research/Pedestrian_Detection/pedestrian_detection.html

Publicatii de referinta:

http://www.gavrila.net/Publications/publications.html

http://www.gavrila.net/Publications/eccv00.pdf

http://www.gavrila.net/pami09.pdf

Prezentare IV2012:

http://www.youtube.com/watch?v=esIwzZN1skE