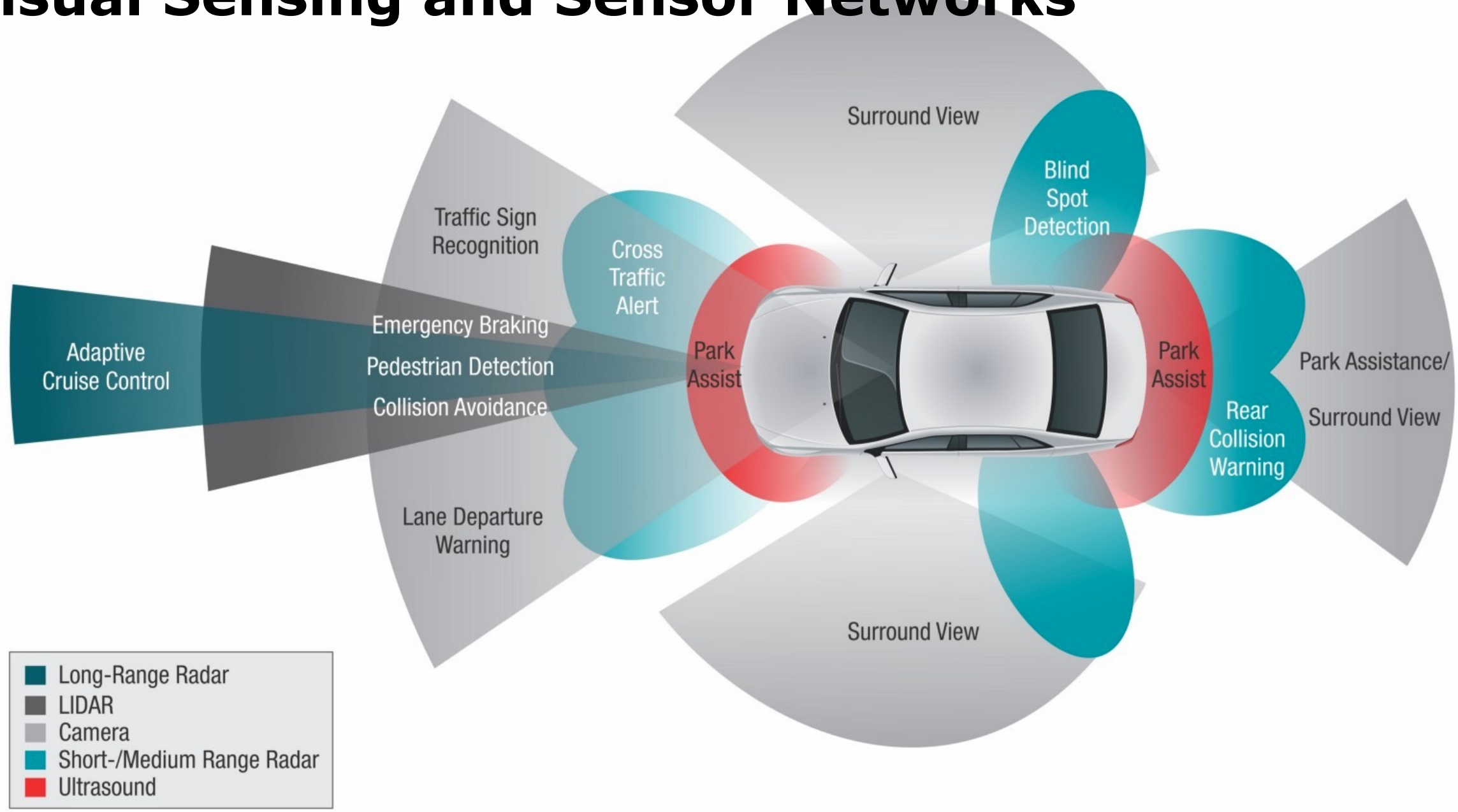
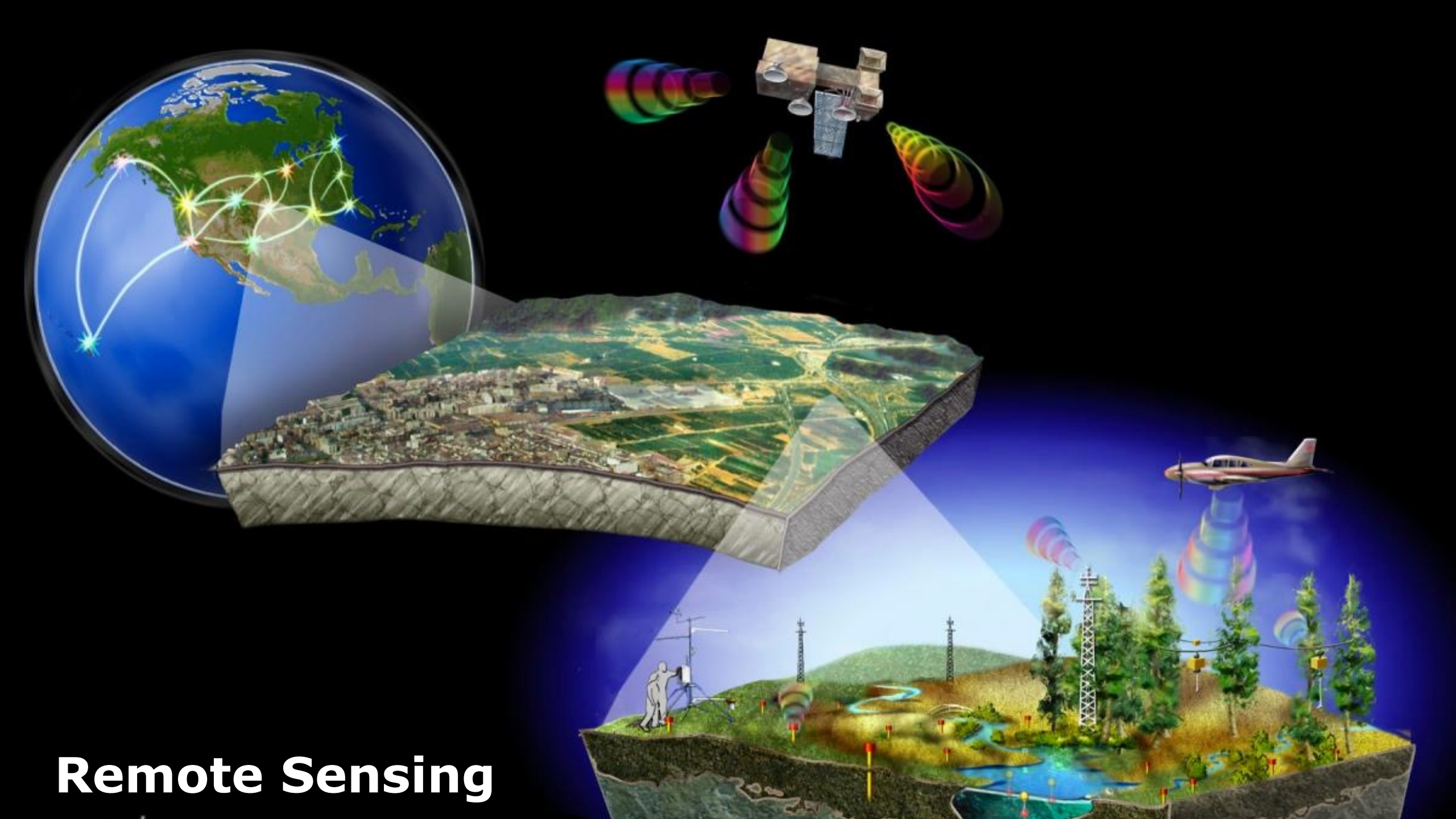
VRIJE UNIVERSITEIT BRUSSEL

Master in de Ingenieurswetenschappen: Computerwetenschappen Profiel Multimedia

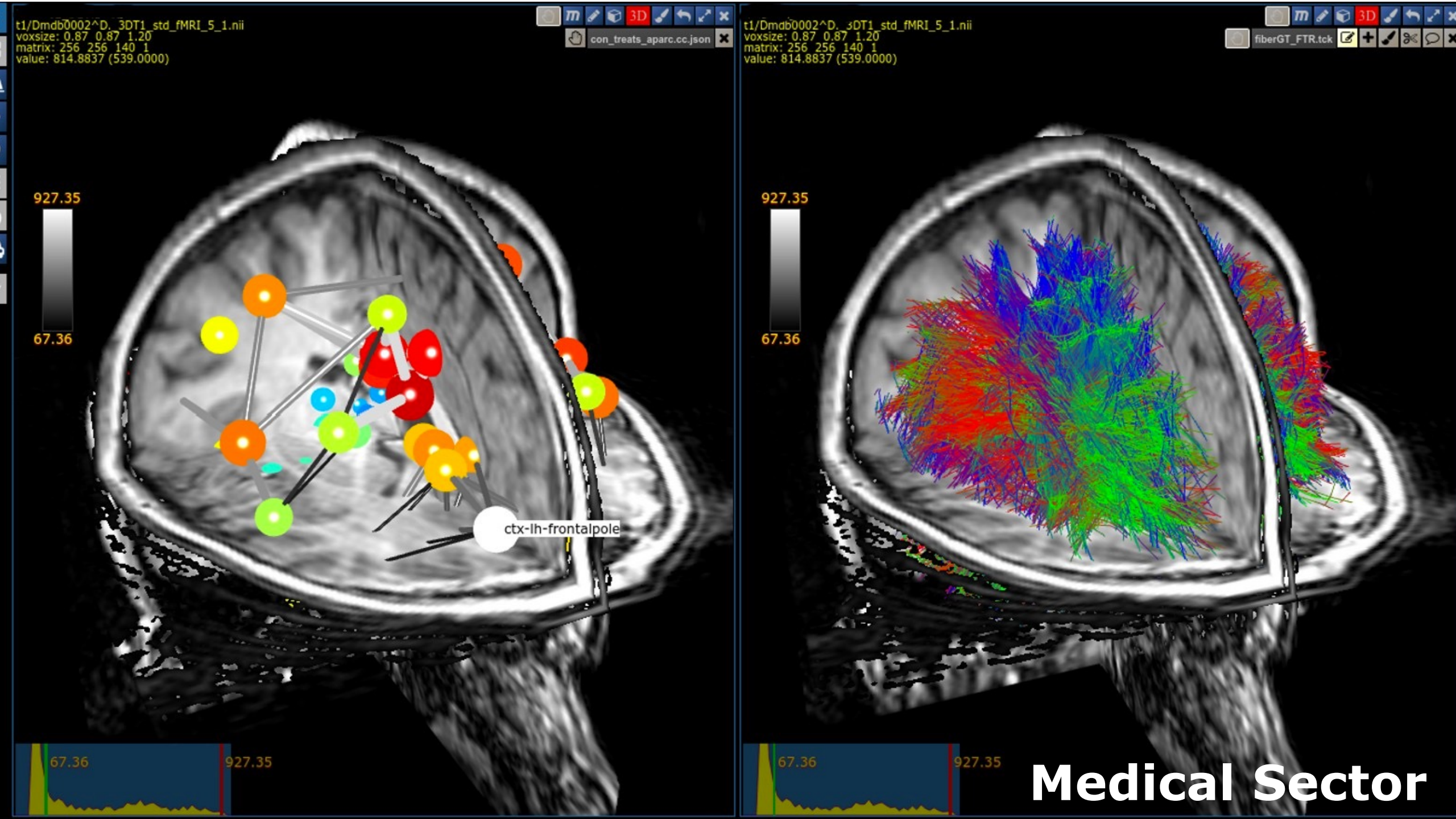
Master in Applied Sciences and Engineering: Computer Science Profile Multimedia

Visual Sensing and Sensor Networks





Remote Sensing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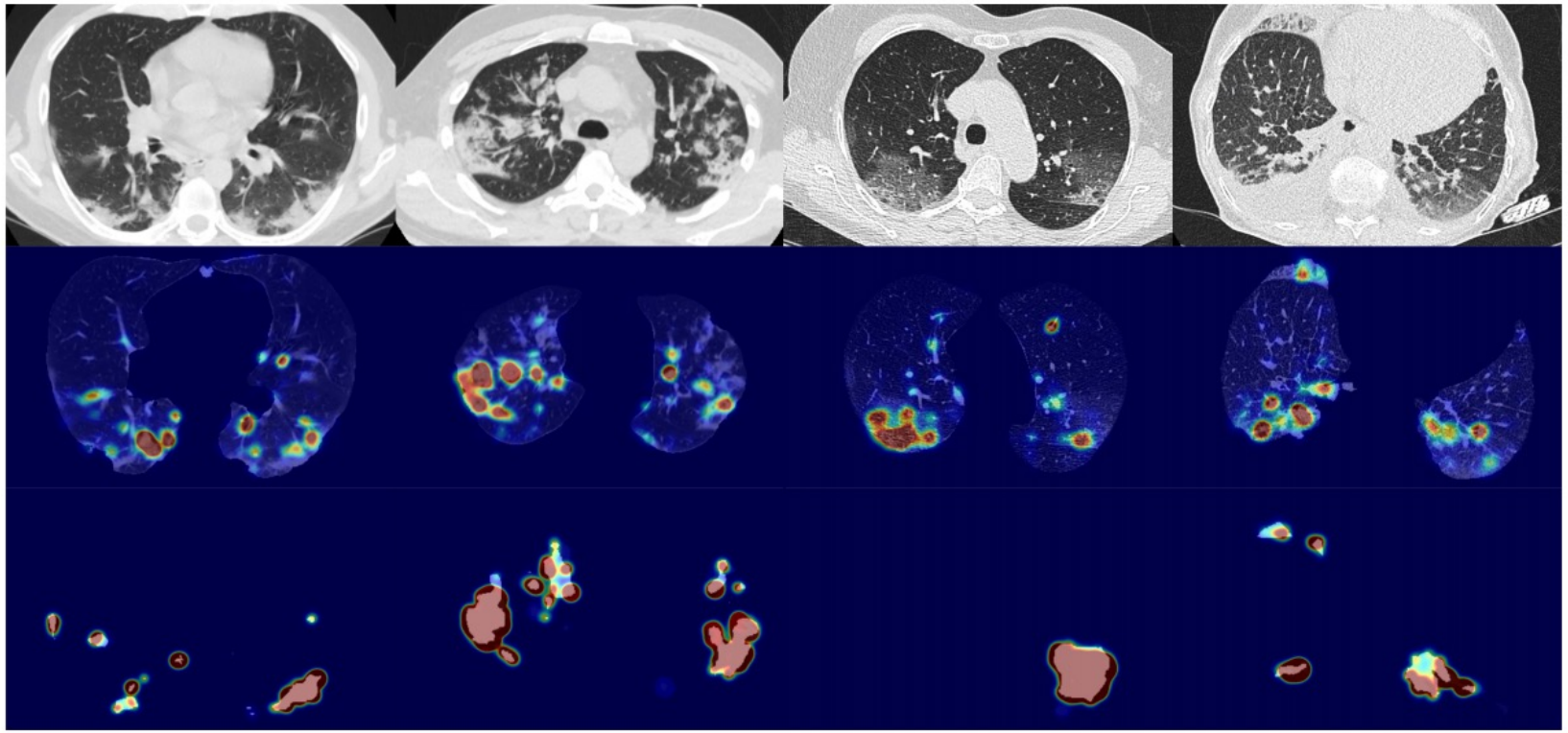
matrix: 256 256 140 1
value: 814.8837 (539.0000)
con_treats_aparc.cc.json
927.35
67.36
ctx-lh-frontalpole
67.36
927.35
t1/Dmdb0002^D._3DT1_std_fMRI_5_1.nii
voxsize: 0.87 0.87 1.20
matrix: 256 256 140 1
value: 814.8837 (539.0000)
fiberGT_FTR.tck
927.35
67.36
67.36
927.35
Medical Sector

Explainable Deep Learning for Covid-19 Detection from CT Scans

- Explanation using Layer-wise Relevance Propagation (LRP), based on a modified backward pass through the CNN

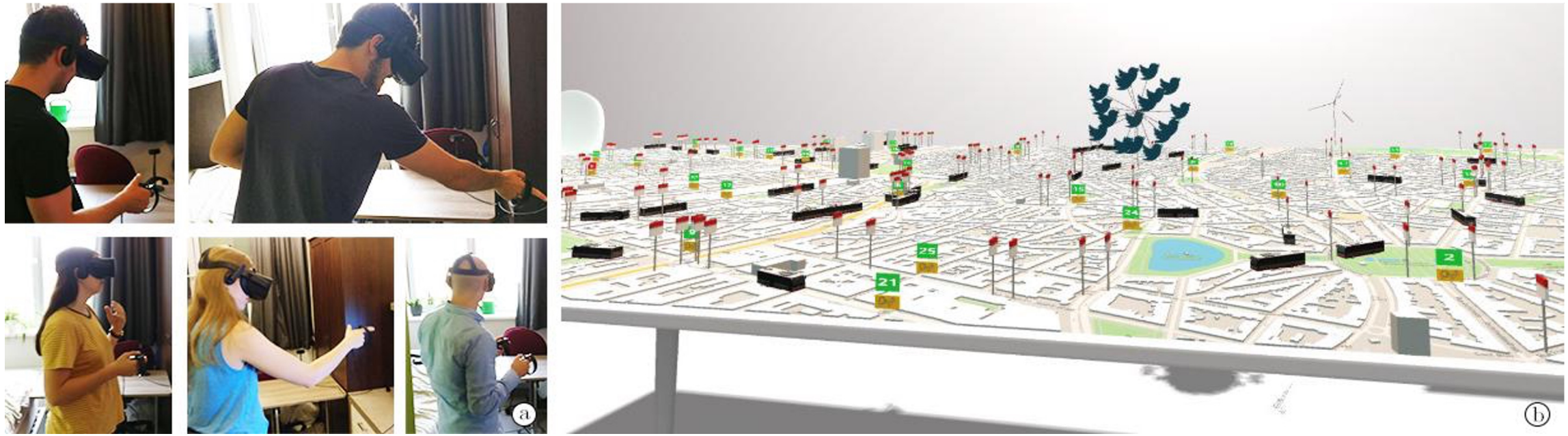
- Heatmaps show relevance scores of multiple input features:
  - Ground glass opacities (GGO)
  - Pre-identified lesions



Berenguer, Abel Díaz, et al. "Explainable-by-design Semi-Supervised Representation Learning for COVID-19 Diagnosis from CT Imaging." *arXiv preprint arXiv:2011.11719* (2020).

VR Visualization of City Data

MobiWave: Big Data Driven Optimization of Mobility and Smart Advertisement in the City



Real-time VR visualization of mobility and social media data in Brussels.

[VR tool visualizing public transformation flows in Brussels; the system enables the user to see on-the-fly the position of STIB buses, the occupancy of Villo stations, geolocated social media posts.]

S. Vanden Broucke, N. Deligiannis, "Visualization of real-time heterogeneous smart city data using virtual reality," in IEEE International Conference on Smart Cities, ICS2'19, 2019.

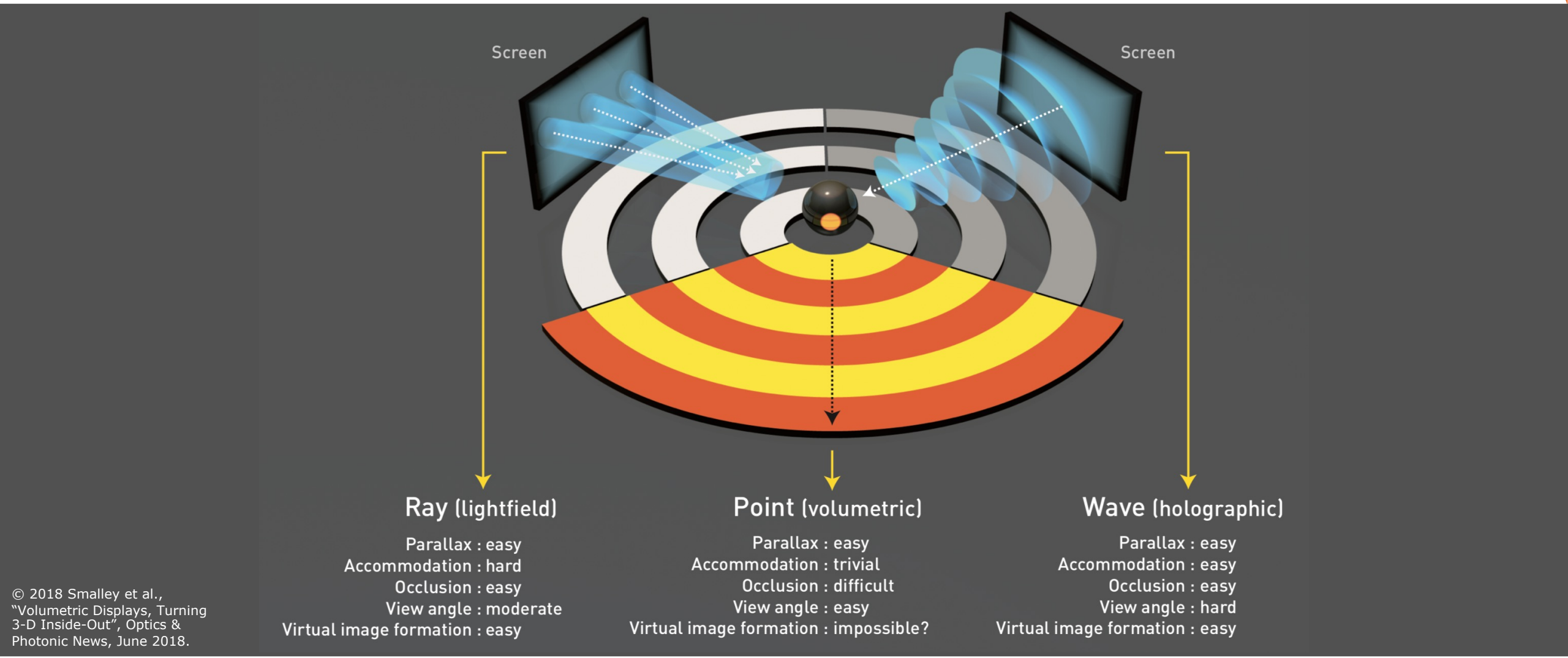
[Demo]

Cultural Heritage

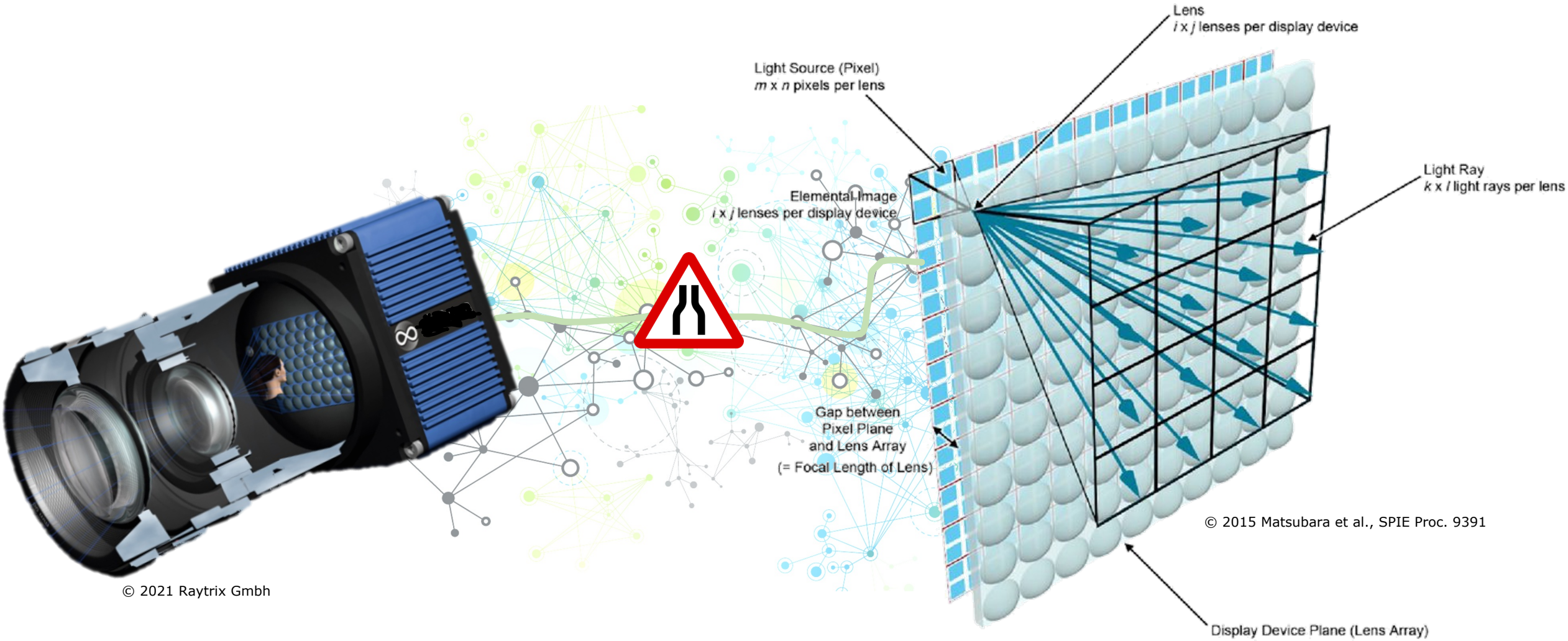
Audiovisual Sector

Plenoptic Imaging

3D display families



Light fields



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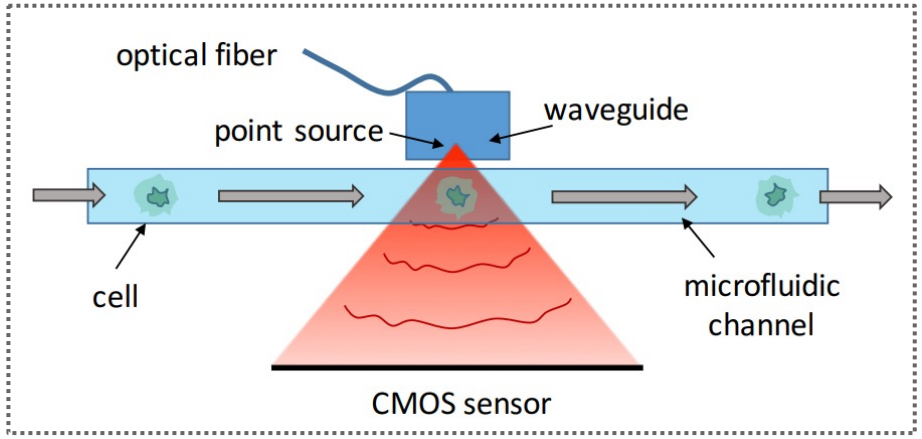
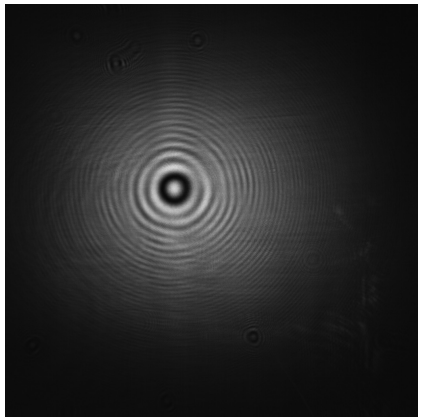
© 2015 Matsubara et al., SPIE Proc. 9391

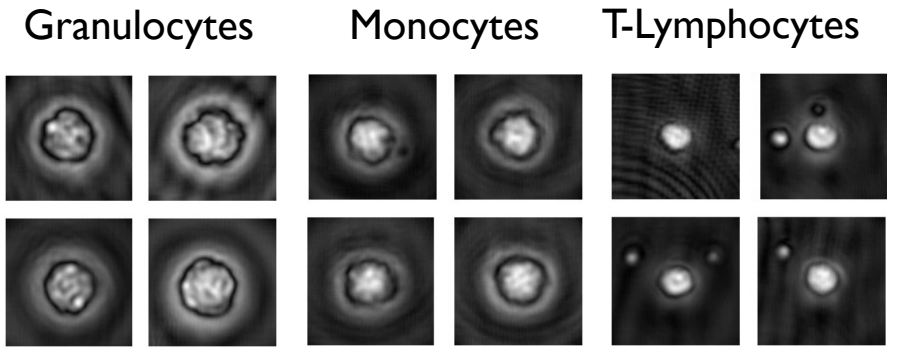
Holographic Microscopy

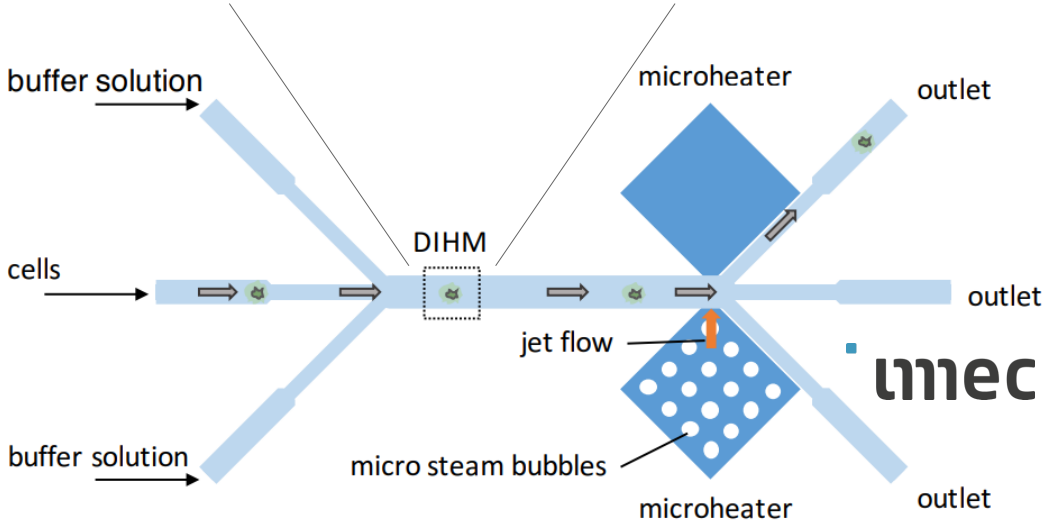
Cell classifier for on-chip lens-free flow cytometry



Example of a hologram





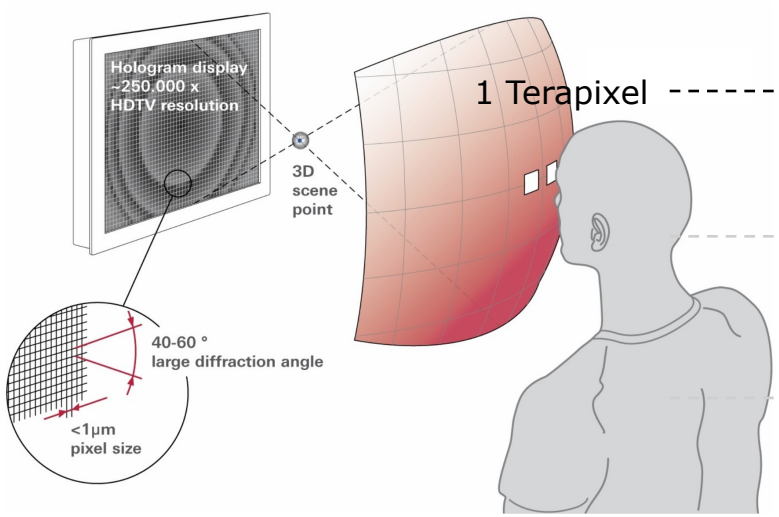


- Classic reconstruction pipeline is computationally costly, complex and not so robust
- Efficient projective transform (0.2 ms on GPU)
- About 97% classification accuracy
- Pending patent application

B. Cornelis, D. Blinder, B. Jansen, L. Lagae and P. Schelkens, “Fast and robust Fourier domain-based classification framework for on-chip lens-free flow cytometry”, *Optics Express*, accepted, 2018.

Holographic Display

Requirements



1 Terapixel

1 Gigapixel

1 Megapixel

40 inch

10 inch

3 inch

1 inch

Table Top Display

Tablet

Mobile

HMD

Wavelength = 460 nm

2,6°
10µm

6,6°
4µm

26,6°
1µm

60°
460nm

180°
230nm

Overview of JPEG Pleno

JPEG Pleno aims to provide a standard framework for representing new imaging modalities, such as texture-plus-depth, light field, point cloud, and holographic imaging. Such imaging should be understood as light representations inspired by the plenoptic function, regardless of which model captured or created all or part of the content.

JPEG Pleno standard tools will be designed together to consider their synergies and dependencies for the whole to be effectively greater than the sum of its parts. To fully exploit this holistic approach, JPEG Pleno is not just a set of efficient coding tools addressing compression efficiency. It is a representation framework understood as a fully integrated system for providing advanced functionality support for image manipulation, metadata, random access and interaction, and various file formats. In addition, it should offer privacy protection, ownershi

The JPEG Pleno framework is end-to-end-from the real or synthe integrating all necessary tools into a single system to represen requirements, and functionalities.

www.jpeg.org

E-mail reflector: jpeg-holo@jpeg.org

To subscribe to the reflector, please visit http://jpeg-holo-list.jpeg.org or in case of problems contact lists@jpeg.org

Master Programme Structure

Programme Master Computer Science

- Compulsory General Courses (60 ECTS)

  - Methods of Scientific Research (Y1, 3 ECTS)
  - Declarative Programming (Y1, 6ECTS)
  - Scientific Integrity (Y1, 3 ECTS)
  - Software Architectures (Y1, 6 ECTS)
  - Open Information Systems (Y1, 6ECTS)
  - Theory of Computation (Y1, 3 ECTS)
  - Information Theory (Y1, 3 ECTS)

  - Research Training (Y2, 6 ECTS)
  - Master Thesis (Y2, 24 ECTS)

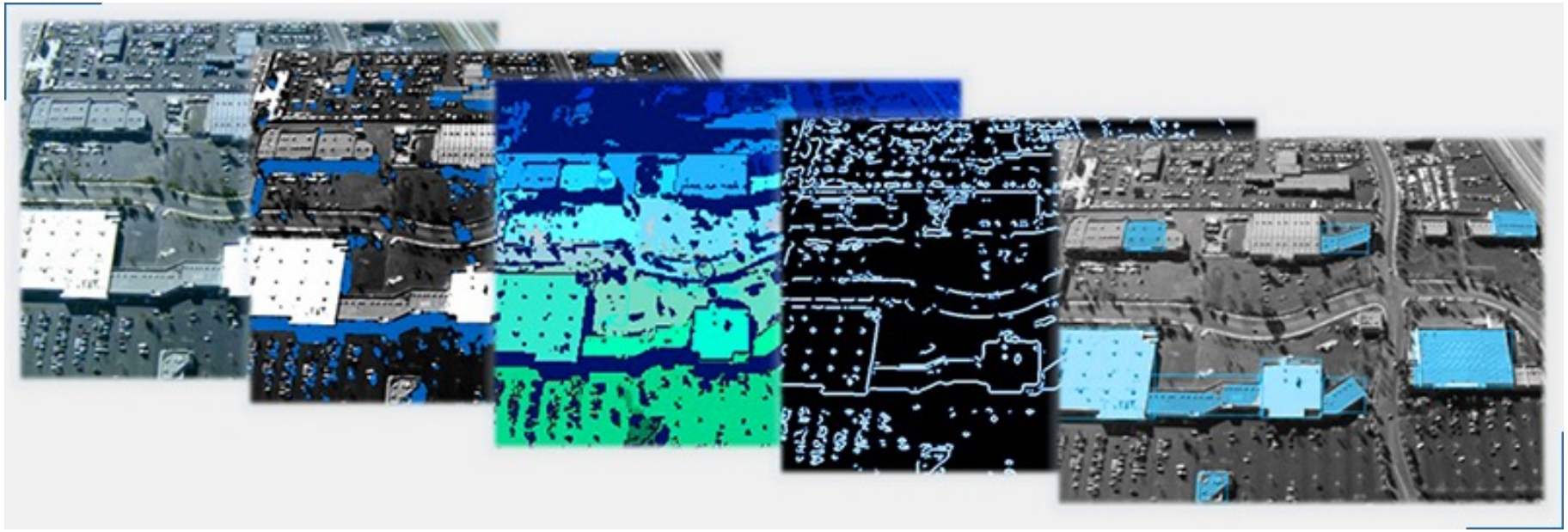
Programme Master Computer Science

- Compulsory Courses Profile Multimedia (20 ECTS)
  - Image Processing (*Y1,* 5 ECTS)
  - Computer Vision (*Y1,* 4 ECTS)
  - Virtual Reality (*Y1,* 5 ECTS)
  - Image and Video Technology (*Y1,* 3 ECTS)
  - Capita Selecta Multimedia (*Y2,* 3 ECTS)
- Optional Courses Profile Multimedia (min. 10 ECTS)
  - Physical Communication (6 ECTS)
  - Computational Geometry (5 ECTS)
  - Stem, beeld, navigatie en telemetrie (5 ECTS)
  - Biomedical Signals and Images (3 ECTS)
  - Multimedia Seminar (3 ECTS)
- Courses from other profiles and other courses (remaining ECTS)

Examples of Courses

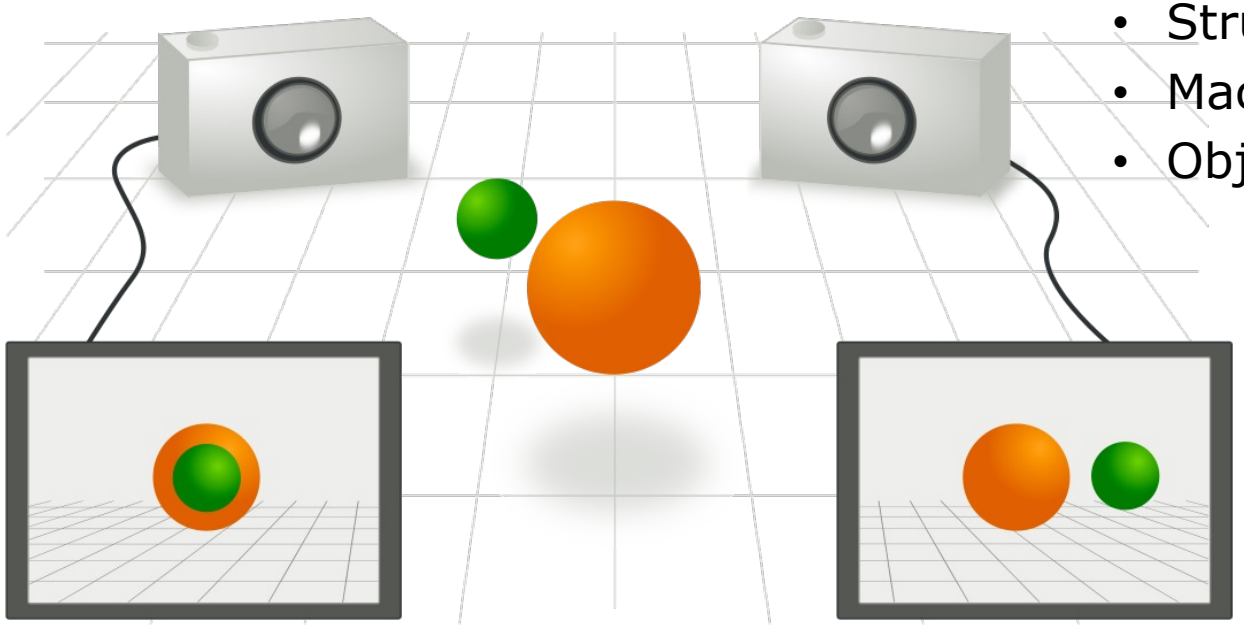
Image Processing (5 ECTS) - Prof. Adrian Munteanu

- Global Image Transforms
- Wavelet Transform
- Image enhancement and image restoration
- Image segmentation
- Mathematical Morphology



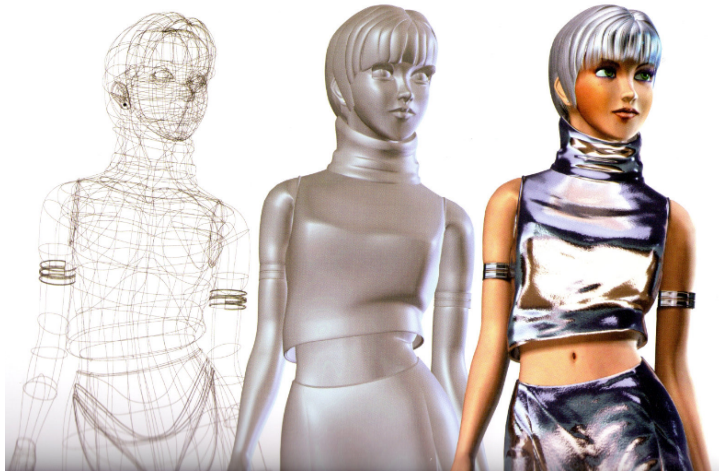
Computer Vision (4 ECTS) - Prof. Hichem Sahli

- Introduction & Review of Linear Algebra, Geometric
- Camera model - Image Formation
- Camera model - image geometry
- Camera model - image radiometry
- Epipolar Geometry & Stereo Reconstruction
- Structure from Motion & Optical Flow
- Structured light & Time of Flight
- Machine learning for Recognition & Classification
- Object detection/classification & tracking



Virtual Reality (5 ECTS) – Prof. Gauthier Lafruit

3D Graphics OpenGL pipeline & Shaders programming



- 3D content formats
- OpenGL rendering pipeline with some maths (projection, quaternions, etc)
- How do VR glasses work?
- Depth sensing
- Photogrammetry
- Raytracing & Radiosity

Virtual Reality Project

Roller coaster

INFO-H-502

ULB ECOLE POLYTECHNIQUE DE BRUXELLES

Programmed with OpenGL & shaders (practical sessions), not with Unity or Unreal (we teach the core of any 3D, not specific software packages).

Virtual Reality (5 ECTS)
4D Replay competition

© 4D Replay

4D Replay weak points:

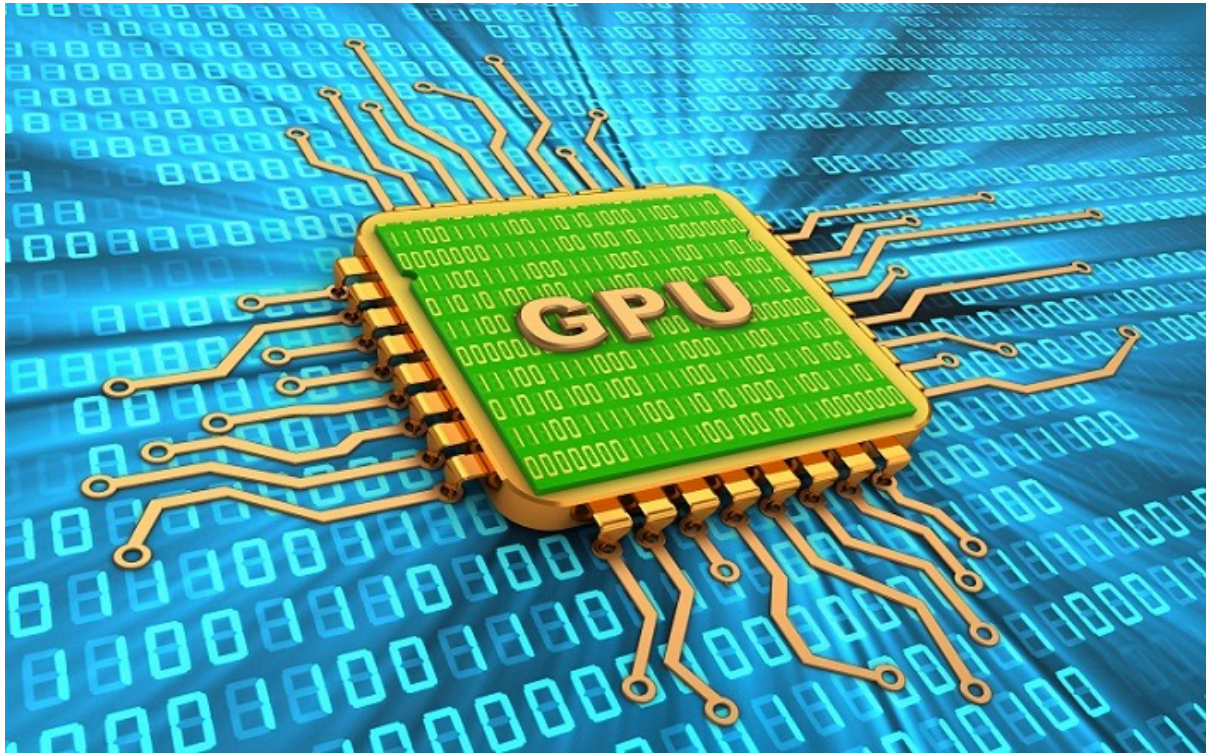
- Discontinuous transitions
- Production side; no client-side VR
- Too many cameras to make it consumer app

Image and Video Technology (3 ECTS) – Prof. Peter Schelkens

- Basic concepts, Human Visual System …
- Entropy coding techniques, lossless coding
- Image coding (JPEG, JPEG 2000, …)
- Video Coding (Basic principles, H.264/AVC, …
- Advanced modalities

GPU Computing (3 ECTS) – Prof. Jan Lemeire

- **Context:** software acceleration by exploiting the fine-grain highly parallel GPU architecture.
- **Main goal:** unleash the power of GPUs. Advanced course on programming and optimizing GPUs.
- **Approach**
  - Understand the semi-abstract scalable processor architecture.
  - Learn and practice the programming paradigm.
  - Understand the performance and get insight into the inefficiencies in order to optimize.
- **Prerequisites:**
  - Good programming skills, knowledge of computer systems
  - Experience with parallel computing (at least multithreaded programming).
- **More information:**
  - http://parallel.vub.ac.be -> teaching or jan.lemeire@vub.be



Cryptography (3 ECTS) – Prof. Ann Dooms

- Building blocks of secret communication within historical/societal context:
  - Symmetric cryptosystems
  - Public-key cryptosystems
- Recapitulation of the underlying mathematical concepts from number theory (Euclidean and modular division, finite fields, …)
- Applications
  - Hash functions, digital signatures and blockchain
  - Homomorphic encryption for privacy preservation
  - Watermarking for multimedia content
  - …