IPAL overview

Image & Pervasive Access Lab

Singaporean-French International Research Unit
(NUS, CNRS, I²R/A*STAR, UJF)

http://ipal.i2r.a-star.edu.sg/

Daniel Racoceeanu & Nicolas Loménie
- **Incubation Unit** for future research leaders
- **Research HUB** for French, European, ASEAN, East and South Asian countries
- Promotion support (**from POC to POV**) for the research outcome in ASEAN emerging economies

French & European Universities

PostDocs, PhDs, Masters

Southeast Asian Universities
(Philippines, Thailand, Vietnam, Malaysia ...)

East and South Asian Universities
(Taiwan, Japan, Korea ...)

PostDocs
PhDs
Masters
IPAL members

28 Persons = 18 Researchers (9 Senior Researchers, 5+2 RF, 2 RA), 8 PhDs, 1 Eng. & 1 AdmCom Assistant
20 EFT (Equivalent Full Time) scientists - 12 EFT Confirmed Scientists & 8 EFT PhDs
Evolution of IPAL topics

1998-2007
IPAL Image Processing and Application Lab
EP 1956 & FRE CNRS 2339
- Image Processing
- Image Indexing and Retrieval
- Image and 3D Perception
- Video Indexing and Retrieval

Project: DIVA
Collaborators: NUH, SERI, UJF

2007-2011
IPAL Image Perception, Access & Language
UMI CNRS 2955
- Content-Based Image/Information Retrieval
- Multilingual Access to Multimodal Images
- Mobile Information Access
- Medical Image Analysis, Indexing and Retrieval

Projects: MMedWeb, ISERE, ONCO-MEDIA, MOSAIC
Collaborators: NUH, SGH, UFC, TELECOM, UPD, UPT

2011-2014
IPAL Image & Pervasive Access Lab
UMI CNRS 2955
- Image Understanding & Visual Reasoning
- Pervasive Access to Image/Information
- 3D Visual Objects Streaming
- Ambient Assistive Living
- Ambient Intelligence

Projects: IVS4NSCell, AMUPADH ...
Collaborators: NUH, SGH, BII/A*STAR
UFC, TELECOM, UPD, UPT ...

- Image Processing
- Image Indexing and Retrieval
- Image and 3D Perception
- Video Indexing and Retrieval
IPAL challenges

Healthcare

Pervasive Exploration of Medical Images for Prognosis and Treatment Assistance

MIU
(Medical Image Understanding)

Wellness

AAL - Ambient Assistive Living and Mobile Information Access

PAWM
(Pervasive Access and Wellbeing Management)

Support

Mobile access to image

Impact

Cognitive prognosis systems

Hospital

Medical Imaging

3D visual objects streaming

Outdoor

Indoor
MIU - Algorithmic Cognitive Medical Imaging

Toward Ontology-Driven Medical Prognosis

Surgery and Treatment Planning

Prognosis

Therapy Simulation

(in cognito)
Cognitive Vision
The European Research Network for Cognitive Computer Vision Systems

Modeling & Traceability

(in silico)
Virtual Physiological Human
VPH - European Program (2008-2012)

Personalized Prognosis

Validation & Knowledge discovery

(in vivo / in vitro)
Medical Image, Signals and Information
Parkinson Disease Prediction

Extracted Mid-brain

Extracted Putamen

3D view of brain with fibers and regions of interest

Results on fiber growth

Brain Volume: 1372271.69 mm³
Right Side
Fiber Volume: 0.0 mm³
Fiber Number: 0
Fiber Density: 0.00 [Vol.fiber/Vol.Mid-Brain]
Mid-brain Volume: 302.0 mm³
Putamen Volume: 639.0 mm³

Left Side
Fiber Volume: 34.440104166666859 mm³
Fiber Number: 6
Fiber Density: 0.11 [Vol.fiber/Vol.Mid-Brain]
Mid-brain Volume: 326.0 mm³
Putamen Volume: 735.0 mm³
StrokePrediCT
3D spine reconstruction results for Scoliosis Quantification

Frontal view (amount of lateral bending shaded in red)  Lateral view
Deep HCI: A vision partnership between Human & Agent

Context-Aware Vision

Human

Agent

Computer-Aided Vision
PAWM - Objective

Real life scenario verification (Leader ALEX-HOSP)

Context understanding (Leader I2R)

Service rendering (Leader IPAL/I2R)

UI plasticity reasoning level

Micro-Context

Smart Home for people with dementia

Software verification and scenario modeling (Leader NUS-SOC)

Context reasoning level

Service & Application level

UI plasticity level

Ambiance Sensors (temp., light, etc.)

RFID/UBIR

Ambient Audio Experience

Video / Image Cameras

Wearable BP Sensors and Accelerometers

IP TV interactive system

Mobile system
Multiple environments

- Kitchen
- Mall
- Office
- Outdoor

Adapted and Continuous Assistance Provision

- Medicine reminder
- Radio
- Window
- Room
- Door
- Traffic light
- Bus schedule
- Assisted navigation
- Building Map
- Elevator
- Advertisement
- Emergency Call
- Emergency Call

Incorporating technologies for assistance in various environments.
Global Village initiative
2005-2014

- Assistance for navigation
- GeoLocalisation Technologies: GPS, EGNOS
- Kiosk for info service access
- Wireless Technologies: Wifi, Wimax...
- Building accessibility information
- Older person confidently doing
- Leisure Center
- City Hall
- Home
- Wireless Technologies: GSM, GPRS, UMTS...
- Service continuity
- Communication
- Older person assisted at home
MIU
Medical Image Understanding
IPAL/MIU framework

Content-Based Medical Image Retrieval

Translational research approaches

Pervasive Exploration of Medical Images for Prognosis and Treatment Assistance
MIU
(Medical Image Understanding)

Healthcare

Cognitive Virtual Microscopy

Medical Imaging for Prognosis
MICO
A COgnitive virtual MIcroscopy platform for histopathological Whole Slide Images Analysis. Application to Breast Cancer Grading

Department of Pathology, National University Hospital, Singapore
Hopital Pitie Salpetriere, Paris, France
Tribvn, Paris, France

ONCO-MEDIA (Stic-Asia) & MMedWeb (A*STAR/SERC) projects
Nottingham Breast Cancer Grading system

a) Tubule formation  
Criteria Score  
TF  
1 >75% tubules  
2 10 - 75% tubules  
3 <10% tubules  
Hyperfield (Frame) Score  
NPS  
Small size and regular shape  
Medium size and varied shape  
Big size and irregular shape  
MC  
< 9  
10-19  
> 19  
Composite score /10 frames  
Global score (TF+NPS+MC)  
Grade I (well differentiated)  
Grade II (moderately differentiated)  
Grade III (poorly differentiated)  
3- 5  
6-7  
8-9  

b) Mitosis

c) Nuclear pleomorphism
Challenge – Whole Slide Image exploration
Functional workflow of MICO

Image Acquisition → ROI Detection

ROI Detection:
- Visual Features Extraction
- Low Resolution Analysis

ROI Grading:
- ROI Exploration
  - High Resolution Analysis
    - Nuclear Pleomorphism
    - Mitotic Count

Ontology-based Retrieval and Validation Support:
- Semantic Reasoning
- Semantic Annotation
- Semantic Query
Multi-Scale Features

magnification

- low (1.2X)
- medium (10X)
- high (20X)
- very high (40X)

ontology

- stroma
- neoplasm
- necrotic zone
- DCIS
- tubule formation

mitosis & nuclear pleomorphism

Fast multi-scale slide scanning / analysis
Semantic Reasoning as Semantic Annotation support

Semantic Annotation

Nuclear Pleomorphism Objects Segmentation and Classification

Semantic Reasoning

Primitive Mitosis-like cells segmentation

Features Extraction (Image Analysis)

Raw Image (Pixel)
Cognitive Virtual Microscopy

- **The Acquisition / Slide Scanner**
- **The Grading**
- **Validation by retrieval**

Virtual slide

Knowledge Management

Ontologies
An Intelligent Vision System for Quantitative Microscopy in Neural Stem Cells Progenitor Growth and Differentiation

Neural Stem Cells Tracking

• This project combines neural stem cell biology, microscopy, image processing and machine learning research to realize an integrated intelligent vision system for systematic studies of neural stem cells.

Image from Olympus FV1000 confocal of 3-5 days old neurospheres
Flow Diagram

Biological
- Sample Preparation
- Image Acquisition
- Manual Annotation for Machine Learning

Summary Report and Hypothesis

Machine Learning
- Cell Group Model Creation / Online Updating
- Cell Splitting Procedure Study
- High-level Concept Summarization

Image Processing
- Basic Image Restoration
- Nucleus Detection
- Segmentation
- Neurite Tracing & Feature Extraction

Specific Domain Knowledge Model (explicit-prior and implicit-updated)

Raw Image Data

Image Features

BII (Bioinformatics Institute)
BIOPOLIS

I2R & IPAL FUSIONOPOLIS

IMB (Institute of Medical Biology)
BIOPOLIS
Neural stems monitoring and neuroregeneration study
IPAL - IMAGE & PERVASIVE ACCESS LAB
International Joint Research Unit (UMI CNRS 2955)

Institute for Infocomm Research (I²R/A*STAR)
French National Research Center (CNRS)
National University of Singapore (NUS)
University Joseph Fourier, Grenoble (UJF)

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