Teaching program

Master VICO

Academic year 2020-2021

Ecole polytechnique de l’université de Nantes

November 25, 2020
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### II  Sheets of courses

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Part I

Tables of teaching units
## Semester 9 - unit M2 VICO

### Advanced Image and Video Processing  
**ECTS : 6**

*Manager : GUEDON Jean-Pierre*

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### Perceptual Computing  
**ECTS : 6**

*Manager : PERREIRA DA SILVA Matthieu*

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### Machine Learning for Computer Vision  
**ECTS : 6**

*Manager : PICAROUGNE Fabien*

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### 3D Computer Graphics  
**ECTS : 6**

*Manager : RICORDEL Vincent*

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### Multimedia Communication  
**ECTS : 2**

*Manager : PRIE Yannick*

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### Human-Computer Interaction  
**ECTS : 2**

*Manager : PRIE Yannick*

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### French Language and European Culture

*Manager: MORVAN Marianne*

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### Initiation to scientific Research

*ECTS: 1*

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### Scientific Talks

*Manager: RICORDEL Vincent*

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*Face-to-face sum*
## Semester 10 - unit M2 VICO

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### Sum of semester

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Part II

Sheets of courses
3D Computer Graphics

Hours
Lect  Tut  PW  Proj  WP  Asst

Evaluation
2 evaluations :
  • Labs
  • Exam

Outline
1. Realtime 3D general concepts
2. 3D Perception
   Visual depth perception
3. 3D and Interaction
4. Computer graphics
   Overview and Basic Math for 3D programming
   OpenGL, Lighting and shadowing
   Introduction of Shaders programming
5. Camera calibration
   Extrinsic and intrinsic parameters
   Multi camera
6. Applications (project)
   Virtual reality at scale 1:1
   Augmented Reality with dedicated peripherals

Goals
At the end of this course, the student must know the visual human mechanisms involved in the depth perception. He will be able to use basic lighting algorithms and basic shaders programming.

The student will also be able to take a critical look to 3D application and their use: he will be able to choose the interaction devices adapted to the type of rendering used and he will be able to choose a visual representation mode adapted to the a defined task with defined interaction device.

Manager : Fabien PICARougne
Advanced Image and Video Processing

Hours
Lect  Tut  PW  Proj  WP  Asst

Evaluation
2 evaluations :
• Labs
• Exam

Outline
Discrete geometry topics :
  • Discrete topology
  • Discrete line, surface and volume
  • Mathematical morphology
  • Discrete measures
  • Discrete reconstruction
Image analysis applications topics:
  • medical imaging
  • materials imaging
  • art imaging

Goals
At the end of this course, the students will be able to:
  Understand the digital objects that constitutes the basis for computation in any image field. Discrete
topology theorems, algorithms for line drawing, convex shape or distance maps, morphological tools and
 discrete reconstruction are presented in order to be able to manage an image problem via these tools.
Manipulate the discrete geometry concepts in a real applicative environment either for medical imaging
(image acquisition, tomography, quantizing image information) or for image analysis (medical, mate-
rials, ...). A large set of examples is available from the teams projects and are applied with the previous
concepts in real time constraints environments.

Manager : Jean-Pierre GUEDON
French Language and European Culture

Hours
Lect  Tut  PW  Proj  WP  Asst

Outline
Grammar
- tenses: présent, futur proche, passé proche, the imperative questions and negations
- pronouns (subject and object)
- some irregular verbs (être, avoir, prendre, faire, aller, venir)
Vocabulary
- days of the week, months, numbers, jobs, food items, clothes, modes of transportation, nationalities...
Phonetics
- difficult vowel and consonant sounds
- liaisons
Culture and civilization
- the outdoor market, Christmas, food and meals, the pace of life in France

Goals
Upon completing the course in French as a foreign language, students will be able to:
- introduce themselves giving basic information about their country, family, studies
- greet native speakers in an appropriate way
- interact with native speakers in routine basic tasks (shopping, ordering at a restaurant)
- fill in registration forms

Manager : Marianne MORVAN
Human-Computer Interaction

Hours
Lect  Tut  PW  Proj  WP  Asst

Evaluation
2 evaluations:
• Labs
• Exam

Outline
1- Human Computer Interaction: from intervention to UX to interaction to interfaces
2- Designing HCI: understanding situations and humans, modeling users and interaction, prototyping and iterating
3- Evaluating HCI: the many facets of HCI evaluation, from expert evaluations to experiments
4- Novel interactions: gesture, voice, touch, haptic-based interactions + AR/VR (see 3D computer graphics)
5- Project.
10 sessions of 2 hours each, 20 hours individual work, 20 hours project work
Each student will make one or two presentation during the course.
Each project will imply 2 or 3 students designing an experimental setting and running a small evaluation to answer an HCI related question

Goals
At the end of this course, the student will be able to design an interactive system using adequate design methods. He will be able to choose an evaluation method and to carry out the evaluation of the system. He will be able to reuse the theoretical (HCI discipline, its history, its main concepts, principles and methods) and practical knowledge acquired during this course in order to write a paper in HCI.
Internship

Hours

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Evaluation

3 evaluations:
- Defense
- Report
- Work

Outline

During the internship, the student will conduct a research work either in a university lab or in a private company’s R&D department.

Goals

At the end of the internship, the student should be able to:

1. Identify and refine a research question or puzzle within an existing field of scientific inquiry and devise a plan for investigating it.
   - Formulate a program of reading in consultation with a professional scientist to provide context for the investigation
   - Develop a time-line for the research project and manage work to that time-line
   - Communicate research results - both orally and in writing - in a style consistent with scientific standards
   - Work as part of a research team

Manager: Matthieu PERREIRA DA SILVA
Machine Learning for Computer Vision

Hours
Lect  Tut  PW  Proj  WP  Asst

Evaluation
2 evaluations:
- Labs
- Exam

Outline
Data preprocessing (normalization), Feature extraction
Classification:
- Mixture models (GMM), Bayesienne decision
- Neural Networks (from MLP to deep-learning), Kernel Machines (SVM), Semi-supervised learning
- Structure recognition (spatial relation analysis, 1D / 2D grammar based system, CYK parsing)
Data set properties (size, diversity, labeling cost)
Applications:
- Offline and Online Handwriting recognition
- Visual object recognition

Goals
At the end of this course, the student will be able to go through the different steps of a computer vision process:
- define the subtasks a complete process
- choose the appropriate datasets, apply necessary preprocessings
- train, optimize and use classical machine learning tools (GMM, MLP, SVM, deeplearning)
- evaluate the spatial relations between objects
- understand a grammar based system to parse complex objects
Multimedia Communication

Hours

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Evaluation

2 evaluations:

- Labs
- Exam

Outline

Cryptography:
- Pseudo-chaotic number generators
- Symetric and Asymmetric Ciphers
- Hash Functions
- Steganography Systems
- Image and video coding:
  - Principles, methods and technics of image and video compression
  - Image and video compression standards
- Advanced image/video coding (scalability, rate-distortion optimization, coding strategy, multi-views)
- Next generation of image and video coding (for immersive video formats)

Goals

Multimedia communications require a careful design of source coding and security.

For this purpose, this module gives advanced notions in Image and Video Coding, and in Cryptography.

At the end of this course, the student will be able:

In the Cryptography domain:
- To provide principles, theory and methods for designing data security and chaos-based data security.
- To be able to design, realize and analyse a chaos-based cryptographic systems.
- To know applications: Images and videos security; Network security and Network access control; Internet of Things (IoT) security; Mobile security.

In the image and video coding domain:
- To know the fundamental principles, methods and technics of image and video compression
- To describe the characteristics of the main image/video compression standards (JPEG, JPEG2000, H26X, MPEG-X video)
- To implement a complete video coding/decoding chain

Manager: Vincent RICORDEL
Perceptual Computing

Hours
Lect  Tut  PW  Prój  WP  Asst

Evaluation
2 evaluations:
- Labs
- Exam

Outline
1. Visual perception: physiology and theories
   - The physics of vision and physiological basis of visual perception (retina, visual pathways, visual cortex)
   - Spatial vision, Color perception, Depth perception, Visual motion perception
   - Shape and object perception. Visual perception theories: Gestalt, Brunswik's probabilistic functionalism, neurophysiological approach, Gregory's theory, Gibson's theory, Marr's computational approach
2. Visual Experiments and modeling
   - Fundamentals of psychophysics, visual perception experiments with humans
   - Visual attention and eyetracking experiments, cognitive aspects
3. Applications: perceptual based processing
   - Perceptual watermarking, Video and image quality assessment, Perceptual image and video coding
   - 3D, stereo and autostereo applications

Goals
At the end of this course, the student will be able to design an experiment that allows him to measure some properties of the human visual system. He should be able to analyse these measures in order to create some theoretical or computational models. He / she will also be able to reuse the theoretical and practical knowledge acquired during this course in order to design and evaluate image and video processing algorithms that take into account the properties of the human visual system.

Manager: Matthieu PERREIRA DA SILVA