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- 2023 Summer School -

New Trends in InformationTechnologies

Courses Information

Name:	New Trends in Information Technologies
Teaching Institutions:	Wasaa Consortium
Location:	Brest, France
Dates:	16th January - 3rd February 2023
Duration:	3 weeks
Course contact hours:	24 hours of academic classes, 12 hours of professional visits to industrial companies, 12 hours of cultural activities, including initiation to French language.
Pre-requisites:	The program is accessible to BSc3-4 or MSc1 students in engineering sciences
Course equivalencies:	6 European Credits (ECTS)
Language of instruction:	English

Wasaa Consortium

The five universities participating in the 2023 Summer School (UBO, UBS, ENIB, ENSTA Bretagne and IMT Atlantique) are members of the Wasaa group.

Wasaa (Western Alliance for Scientific Actions with Australia) is a consortium of French higher education institutions in Western France interested in establishing partnerships with higher education institutions in Australia. Wasaa's objectives are to strengthen research partnerships between signatory institutions and encourage student exchanges between France and Australia.

The program has obtained the label "Creative France short program" awarded by the Embassy of France in Australia in 2019.

Instructors Information

The courses are taught by:

- A: **Asso. Prof. Panagiotis Papadakis**: 3D Vision for autonomous vehicles (IMT Atlantique)
- A: **Asso. Prof. Mihaï Andries**: Introduction to Robotics and Human-Robot Interaction (IMT Atlantique)
- B: **Asso. Prof. Cédric Fleury**: Virtual Reality, theory and practice (IMT Atlantique)
- B: **Asso. Prof. Étienne Peillard**: Hands on Augmented Reality (IMT Atlantique)
- B: **Prof. Thierry Duval**: Cooperation in Virtual Reality (IMT Atlantique)
- C: **Asso. Prof. Mikaël Guegan**: Introduction to Fiber-Optic Communications and Power over Fiber Systems (ENIB)
- C: **Asso. Prof. Johanne Vincent**: Cybersecurity Awareness (IMT Atlantique)
- C: **Asso. Prof. Benjamin Potelon**: Principle of RF space communications systems (IMT Atlantique)
- D: **Asso.Prof. Nicolas Farrugia**: Practical Machine Learning Applied to Brain Signals (IMT Atlantique)
- D: **Asso. Prof. Nathalie Le Bigot**: Cognitive psychology and experimental campaigns (UBO)
- D: **Asso. Prof. Sorin Moga**: Introduction to Experimental Design with Physiological Measurement (IMT Atlantique)

- **Prof. Christine Chauvin**, (UBS): Human Factors
- **Prof. Jean-Louis de Bougrenet** (IMT Atlantique): Optics
- **Asso. Profs. Catherine Sablé** and **Nadia Zeini** (IMT Atlantique): French Langage and Intercultural Skills
- **Asso. Prof. Guillaume Doyen** (IMT Atlantique): Cybersecurity

Materials

Students will be provided with all learning materials (including relevant reading lists) on arrival at IMT Atlantique. During the program students will have access to computing facilities, though students are advised to bring their own laptop if they have one.

Course Description and Learning Outcomes

The course will allow students to explore the latest trends in information technologies, including virtual reality, artificial intelligence, human factors, robotics, cybersecurity, optical and satellite communications.

The summer school will also be a first introduction to laboratory research work as well as a discovery of the French academic environment.

For their research project, the students will be integrated into the research laboratories of IMT Atlantique, ENSTA Bretagne, UBO or ENIB where they will carry out research work in small groups (maximum 5 students) supervised by professors and PhD students.

It will finally be an opportunity for the students to discover French Language and French Culture (12 hours of courses) including a supper in a gourmet restaurant.

For the technical courses, the students will have to choose one set of three courses among 4 possible tracks:

- A- Artificial Intelligence and Robotics
- B- Virtual Reality and Augmented Reality
- C- Communication Systems
- D- Human Factors

TRACK	A	B	C	D
	Artificial Intelligence and Robotics	**Virtual and Augmented Reality**	**Communication Systems**	**Human factors**
Wednesday 18 9-12	3D Vision for autonomous vehicles 1	Virtual Reality, theory and practice 1	Principle of RF Space Communications systems 1	Introduction to Experimental Design with Physiological Measurement 1
Thursday 19 14-17	3D Vision for autonomous vehicles 2	Virtual Reality, theory and practice 2	Principle of RF Space Communications systems 2	Introduction to Experimental Design with Physiological Measurement 2
Monday 23 14-17	Introduction to Robotics and Human-Robot Interaction 1	Hands on Augmented Reality 1	Introduction to Fiber-Optic Communications 1	Practical machine learning applied to brain signals 1
Thursday 26 14-17	**Keynote lecture 1**			
Friday 27 14-17	Introduction to Robotics and Human-Robot Interaction 2	Hands on Augmented Reality 2	Cybersecurity Awareness 1	Experimental psychology, cognition and virtual reality 1
Tuesday 31 9-12	**Keynote lecture 2**			
Tuesday 31 14-17	3D Vision for autonomous vehicles 3	Cooperation in Virtual Reality 1	Cybersecurity Awareness 2	Experimental psychology, cognition and virtual reality 2
Wednesday 1 9-12	3D Vision for autonomous vehicles 4	Cooperation in Virtual Reality 2	Introduction to Fiber-Optic Communications 2	Practical machine learning applied to brain signals 2
Wednesday 1 14-17	**Keynote lecture 3**			

*The schedule may be subject to change to take into account organizational constraints

Track A: Artificial Intelligence and Robotics

Title of the module	3D Vision for autonomous vehicles
Teacher	Panagiotis Papadakis
Institution	IMT Atlantique
Number of hours	12h

Presentation:

The course will introduce students to the geometry of 3D vision using a single or two cameras. It will present the basics of monocular vision by explaining the notions of intrinsic and extrinsic parameters of a camera as well as the process of calibration. Notions of epipolar geometry will then be presented for the case of two camera views, together with algorithms for estimation of camera movement and sparse 3D structure computation via triangulation.

The students will have hands-on experience on the above concepts via interactive lab sessions where they will be using cameras as well as previously captured images or videos. In detail, projects of varying difficulty will be proposed: (i) camera calibration, (ii) augmented-reality, (iii) camera pose estimation and (iv) sparse structure from motion.

The evaluation of the course will be done by lab-deliverables and a Q&A exam.

Requirements

- Necessary: Object-Oriented Programming using Python
- Desired: OpenCV

Organisation: 1/3 of total time dedicated to scientific courses and remaining 2/3 to interactive lab sessions

Title of the module	Introduction to Robotics and Human-Robot Interaction	
Teacher	Mihaï Andries	
Institution	IMT Atlantique	
Number of hours	6h	

Presentation:

This course will provide a practical introduction to robotics. It will introduce you to modern robotics software tools and raise awarness about common difficulties.

More specifically, the course will introduce you to the Robot Operating System (ROS) middleware, the Gazebo and PyBullet simulators, and reproducibility tools like Docker and Singularity.

The practical work will consist in an implementation of a human-robot interaction scenario inside a simulator. The evaluation will be based on the software-design choices made, and the reproducibility of the simulated experimental scenario.

Requirements:

- Programming skills (C++ and Python)
- Optional: PyBullet, ROS

Organisation: One hour introductory lesson, followed by 5 hours (2+3 hours) of interactive lab sessions.

Track B: Virtual Reality and Augmented Reality

Title of the module	Virtual Reality, theory and practice
Teacher	Cédric Fleury
Institution	IMT Atlantique
Number of hours	6h

Presentation:

This course is both a theoretical and practical introduction to Virtual Reality. It will provide the basis for understanding and developing an immersive application.
It will start with a presentation of Virtual Reality, both from a technical point of view but also of the concepts to be understood in order to design an immersive application. It will then be followed by practical work to develop such an application on VR headsets. The objective is the realization of a VR application allowing a good immersion and 3D interactions with virtual objects.
The evaluation will be based on the implementation of this application and the design choices and justifications made to achieve it.

Requirements

- Basics in Object-oriented programming (C# will be used during the module)
- *Optional:* Unity3D

Organisation: 6 hours of interactive lab sessions including 2 short introductory lessons. 2x (20 min + 2h40)

Title of the module	Hands on Augmented Reality
Teacher	Étienne Peillard
Institution	IMT Atlantique
Number of hours	6h

Presentation:

This course will allow you to discover and implement several types of Augmented Reality. It will start with a short theoretical introduction session to specify the differences (and similarities) between AR and VR. Then the majority of the module will be based on practical work. It will be composed of three (or four) independent projects allowing to implement several technologies allowing to make Augmented Reality: 1) an Augmented Reality headset like Hololens; 2) a tablet solution (based on a marker or using dedicated libraries); 3) a camera-projector solution allowing to make projected Augmented Reality. The students will have to implement application solutions for each of the mentioned technologies.
The evaluation will be based on the implementation of these technologies and the design choices and justifications made to achieve them.

Requirements

- Basics in Object-oriented programming (C# and C++ will be used during the module)
- Optional: Unity3D
- Course "Virtual Reality, theory and practice"

Organisation: 6 hours of interactive lab sessions including a short introductory lesson.

Title of the module	Cooperation in Virtual Reality
Teacher	Prof. Thierry Duval
Institution	IMT Atlantique
Number of hours	6 hours

Presentation:

During this course we will present the basic concepts of Collaborative Virtual Reality (a.k.a Collaborative Virtual Environments) which aims at enabling several users to cooperate within a virtual environment. First we will expose the requirements of such systems from the point of view of the end-users who want to collaborate in a shared virtual environment. Then we will discuss the most common metaphors used to make a user aware of the activity of the other users, and the different kinds of software and network architectures able to meet these requirements for such shared virtual environments. We will also realize a small project under Unity3D to implement some concepts discussed during the course, making it possible to share a virtual environment between several users distributed over a Local Area Network.

Requirements:

- Basics in Object-oriented programming (C# will be used during the module)
- Optional: Unity3D
- Course "Virtual Reality, theory and practice"

Organisation: 2h lessons and 4h labs

Track C: Communication Systems

Title of the module	Introduction to Fiber-Optic Communications and Power over Fiber Systems
Teacher	Mikaël GUEGAN
Institution	École Nationale d'Ingénieurs de Brest (ENIB)
Number of hours	6 hours

Presentation:

The main goal of this class is to introduce students to the field of fibre-optic communications and to the recently developed power over fibre systems for sensors monitoring and feeding. An overview on a typical optical communication link will be presented involving the description of the main used devices such as the optical fibre characteristics, the transmitter and receiver (modem) properties. A specific focus will be made about the power over fibre systems used to transmit energy and to exchange data with a network of sensors: it is an interesting solution within the framework of hostile environments.
Mainly devoted to the dissemination of the key concepts, this course will lean on practical classes and laboratories of demonstration using a dedicated simulation tool and specific material equipment and instrumentations (optical spectrum analyser, reflectometer...).

Requirements

No special requirements as this course is mainly an introduction and dissemination about the key concepts of fibre-optic communications systems.

Organisation: 3 hour of lecture + 3 hours of labs

Title of the module	Cybersecurity Awareness
Teacher	Johanne VINCENT
Institution	IMT Atlantique
Number of hours	6 hours

Presentation:

In the past few years, cyber-attacks have increased drastically against states, companies, or the public. In this brief introduction to cybersecurity, you will learn the basic concepts of cybersecurity and will learn about the best practices in computer security.
Goals:
- Understand the motivations behind the need for security
- Comprehend methods and norms for security
- Learn the basic definitions and typology of threats
- Learn the best practices for both personal and professional IT
- Understand basic system and network vulnerabilities
- Introduction to cryptography
- Grasp the difficulties of implementing security mechanisms in organizations

Requirements:

- Basic knowledge in information systems, computer networks, OS, and applications

Organisation: lectures VS Labs

Title of the module	Principle of RF space communications systems
Teacher	Benjamin POTELON
Institution	IMT Atlantique
Number of hours	6 hours

Presentation:

The main goal of this course is to introduce students to the field of Radio-Frequency communications and particularly microwave systems dedicated to space applications. An overview of the paradigm of microwave links will be detailed and key RF link budget issues will be introduced.
Focus will then be made on the architecture of the transmitter and receiver systems and specific features of the main components will be highlighted (antennas, filters, amplifiers, mixer).

Requirements: No specific requirements.

Organisation: 6 hours of lecture

Track D: Human Factors

Title of the module	Practical Machine Learning Applied to Brain Signals
Teacher	Nicholas FARRUGIA
Institution	IMT Atlantique
Number of hours	6 hours

Presentation:

This course is hands-on tutorial on machine learning applied to brain signals. We will begin by a short course on basics of scientific data analysis, including basic statistics on temporal and spatial signals, as well as basic modeling. We will directly these techniques to brain signals to open datasets coming from function Magnetic Resonance Imaging (fMRI) with human participants. Next, we will introduce the basics of machine learning with a practical approach using the python packages sklearn and nilearn. Students will work on machine learning problems on open fMRI datasets, such as predicting object categories from brain activity of subjects looking at pictures, modeling whole brain activity of subjects watching videos, predicting age from brain structure, or classifying brain disorders using spontaneous brain activity.

Requirements:

- Basics in Python programming
- Optional: Scientific Python (Numpy – Scipy - Matplotlib)

Organisation: 6 hours of interatctive lab sessions including 2 short introductory lessons. 2x (20 min + 2h40)

Title of the module	Introduction to Experimental Design with Physiological Measurement
Teacher	Sorin MOGA
Institution	IMT Atlantique
Number of hours	6 hours

Presentation:

This interactive teaching aims at introducing the different steps of an experimental plan.
- How to formulate a hypothesis based on literature basis or pragmatic conviction?
- What are the different issues when setting up an experimental plan?

Feasible measured variables in ecological situation will be identified and examples of data set and results analysis to verify hypothesis will be tackled.
We will keep a special focus on sleep studies and physiological data collection.
After presenting experimental concepts and examples, we will manipulate real time physiological measurement tools (HR, EEG and/or breath rhythm ...) and students will be asked to imagine original studies on their own.

Requirements: no special requirements.

Organisation: 2 hours of lectures + 4 hours of labs

Title of the module	Experimental psychology, cognition and virtual reality
Teacher	Nathalie Le Bigot
Institution	UBO
Number of Hours	6h

Presentation:

This course focuses on human cognition in virtual reality. It will present how and why to study human cognition using of virtual or augmented reality.

The course will first present some basics in experimental psychology. Then, experiments designed to study cognition in virtual reality will be presented. The purpose is twofold, on the one hand, to identify the cognitive mechanisms specifically involved in virtual reality, on the other hand, to identify the methodology used to study them. Afterwards, limitations and benefits of using virtual reality to study human cognition will be discussed and some advices on how to design an experimental protocol in virtual reality will be given. Finally participants will design an experimental protocol to evaluate a virtual reality application.

The evaluation will be based on the proposition of an evaluating protocol of a virtual reality application.

Requirements: Course "Virtual Reality, theory and practice"

Organisation: 4 hours lessons and 2 hours of interactive lab

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General Timetable*

Date	AM	PM
Monday 16	Welcome Presentation of the program	Opening ceremony Free time in Brest
Tuesday 17	Introduction to French Language 1	Industry visit
Wednesday 18	Technical Course 1	Research Project presentation
Thursday 19	Introduction to French Language 2	Technical Course 2
Friday 20	Introduction to French Language 3	Research Project 1
Samedi 21	Cultural visit	
Monday 23	Introduction to French Language 4	Technical Course 3
Tuesday 24	Research Projet 2	Industry Visit
Wednesday 25	FabLab Open Factory (half group) or free time	FabLab Open Factory (half group) or free time
Thursday 26	Research Project 3	Keynote lecture 1
Friday 27	Research Project 4	Technical Course 4
Samedi 28		
Monday 30	Introduction to French Language 5	Industry visit
Tuesday 31	Keynote lecture 2	Technical Course 5
Wednesday 1	Technical Course 6	Keynote lecture 3
Thursday 2	Research Project 5	Research Project 6
Friday 3	Research Project	Research Project/end of program

*The schedule may be subject to change to take into account organizational constraints

Visits

The industrial visits will focus mainly on companies involved in Advanced Digital Technologies sectors.

The students will also have the opportunity to visit the European Virtual Reality Centre.

From the first week they will be informed of the research project they will be able to work on during the three weeks and the defense of which will set the end of the summer school.

A dedicated half day will allow the students to discover UBO's FabLab and build their own prototype.

Cultural activities

Cultural visits will give the students a chance to discover Brest and its beautiful surroundings such as:

- The bulky Ruins of the Medieval Abbey of St-Mathieu*
- The historical Market of St-Renan*
- Les Capucins, the historical mechanical workshops of the arsenal of Brest

During all the three weeks the students will also be proposed evening and social activities with French and international students.

*the cultural program is to be confirmed and may vary depending on weather conditions and organizational constraints.

Projects

The assignment of research projects will be based on the students' background and their professional project. It will be confirmed during the first week of the summer school.

The content of the research projects will be related to the respective stream attending by students and will be will be done in small groups.

Learning outcomes

The objective of the course is:

1) To introduce students to the diversity and attractiveness of new developments in information technologies and to raise their awareness of their impacts on industry and society.

2) To acculturate them to the French higher education system.

3) To raise their awareness of research work in this field by immersing them in the research laboratories of partner universities.

Validation and Credits

Students will be required to comply with IMT Atlantique's policies regarding plagiarism and academic integrity.
Students will receive an academic record for the course as well as a certificate.
Students who meet the requirements of the three weeks will be awarded 6 credits (ECTS).

Visits: Regular participation in the proposed activities 30%
Courses: Small MCQ at the end of each course module 30%
Project: Twenty minutes of oral presentation of their project results 40%

Grade description

Excellent achievement **Participation:** • Exceeded expectations • Participated actively in all classes conferences and site visits; asked relevant questions • Contributed to class with relevant information. • Demonstrated cross cultural understanding **MCQ: 75-100%** **Project Defense:** • Exceeded expectations • Demonstrated above average knowledge of topic. • Innovative: used variety of materials to convey information • Conveyed information in clear, informative and entertaining manner. • Presentation was engaging for classmates.	75-100%
Good achievement **Participation:** • Participated actively in class and visits • Was engaged • Some participation was not clearly focused **MCQ: 50-75%** **Project Defense:** • Presentation was interesting and engaging, but lacked some clarity and explanation • Failed to engage the full class • Was unable to answer some of the questions	50-75%
Fail **Participation:** • Scarcely participated • Showed no engagement in class • Student was engaged in other activities during classes and visits • Demonstrated no cross cultural understanding **MCQ < 50%** **Project Defense:** • Presentation lacked clarity and was not engaging of fellow students in the classroom	59-0%