CS-444 **Virtual reality**

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Cursus	Sem.	Type
Computer science minor	E	Opt.
Computer science	MA2, MA4	Opt.
Cybersecurity	MA2, MA4	Opt.
Data Science	MA2, MA4	Opt.
Digital Humanities	MA2, MA4	Opt.
Learning Sciences		Opt.
Minor in digital humanities, media and society	E	Opt.
Neuro-X minor	E	Opt.
Neuro-X	MA2, MA4	Opt.
Robotics, Control and Intelligent Systems		Opt.
SC master EPFL	MA2, MA4	Opt.

Language of teaching	English
Credits	6
Session	Summer
Semester	Spring
Exam	During the semester
Workload	180h
Weeks	14
Hours	**3 weekly**
Lecture	2 weekly
Project	1 weekly
Number of positions	

Summary

The goal of VR is to embed the users in a potentially complex virtual environment while ensuring that they are able to react as if this environment were real. The course provides a human perception-action background and describes the key programming techniques for achieving efficient VR applications

Content

The first lectures focus more on the technical means (hw & sw) for acheiving the hands-on coding sessions:

- Visual display
- Interaction devices and sensors
- Software environment (UNITY3D, programming in C#)

The proportion of more theoretical VR and Neuroscience background increases over the semester:

- Key Human perception abilities, cybersickness, immersion, presence and flow
- Basic 3D interaction techniques: Magic vs Naturalism
- The perception of action
- Haptic interaction
- What makes a virtual human looking alive ?
- VR, cognitive science and true experimental design

The group project focuses on CODING a 3D VR game. So we recommend to rather attend DH-414 "Game design & prototying" in case of lack of coding background as this latter does not require coding skills.

Spring 2024-25 will be the last instance of CS-444 in the study plan.

Keywords

3D interaction, display, sensors, immersion, presence, embodiment

Learning Prerequisites

Required courses

Mastering an Object-Oriented programming language

Recommended courses

(CS-341) Computer graphics

Important concepts to start the course

1) Object Oriented programming lies at the core of the project development in C# with Unity3D. Some programming experience with this approach is compulsory as all students will be assessed on the individual coding of some features of the project.
2) from Computer Graphics:
- perspective transformations
- representation and manipulation of 3D orientation
- 3D modelling hierarchy
- matrix algebra: translation, orientation, composition

Learning Outcomes

By the end of the course, the student must be able to:

- Describe how the human perception-action system is exploited in VR
- Apply the concepts of immersions, presence and flow
- Give an example of applications of VR in different industrial sectors
- Choose a method of immersion suited for a given 3D interaction context
- Explain the possible causes of cybersickness in a given VR system configuration
- Design a VR system involving 3D interactions
- Describe how the human perception-action system is exploited in VR
- Apply the concepts of immersion, presence and flow
- Give an example of applications of VR in different inustrial sectors
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- Design a VR system involving 3D interactions
- Give an example of applications of VR in different industrial sectors

Transversal skills

- Set objectives and design an action plan to reach those objectives.
- Assess one's own level of skill acquisition, and plan their on-going learning goals.

Teaching methods

Ex cathedra + Hands-on sessions on VR devices in the first half of the semester,
A mini-project in groups of 2-3 persons will have to integrate various components of 3D real-time interaction (in C# within Unity3D). The group will submit their project proposal to the course responsible TAs who will assess whether it meets the key specifications and is original enough. The proposal will include the use of some VR devices that the IIG research group will lend during the mini-project period. The project development will have to be conducted with git.

Expected student activities

exploit citation analysis tools to evaluate a scientific paper
combine 3D interaction components to produce an original 3D experience
experiment the hands-on practical work in the lab
synthesize the knowledge acquired in course and hands-on in the theoretical oral and the project oral

Assessment methods

Scientific paper study : summary of contributions and citation analysis (around week6 of the semester)
Theoretical oral exam (last week of the semester)
Project assessment through code repository, report and oral exam around the end of the semester

Supervision

Office hours	No
Assistants	Yes
Forum	Yes

Resources

Virtual desktop infrastructure (VDI)

No

Bibliography

- Course notes will be updated and made available after each course, with links to key sites and on-line documents
- Doug A. Bowman, Ernst Kruijff, Joseph J. LaViola, and Ivan Poupyrev. 2017. 3D User Interfaces: Theory and Practice. Second edition, Addison Wesley Longman Publishing Co., Inc., Redwood City, CA, USA.
- J. Jerald, The VR Book, ACM Press 2015
- Parisi, Learning Virtual Reality, O'Reilly 2015

Ressources en bibliothèque

- 3D User Interfaces / Bowman
- Learning Virtual Reality / Parisi
- The VR book / Jerald

Notes/Handbook

pdf of slides are made visible after the ex-cathedra courses

Websites

- http://www.thevrbook.net/
- http://gitlab.epfl.ch

Moodle Link

- https://go.epfl.ch/CS-444