(1.) Course Title: INFPHD627 Image processing/Computer vision (complex exam preparatory)	**Credits: 6**
Course **Classification: Mandatory chosen**	
Theoretical or Practical Nature of the Course, *'training character'*[13]: 100% theoretical (credit%)	
Type of Class: consultation and **number of hours**: **2/week** in the given semester, *(If the course is not (only) taught in Hungarian, then **the language**: **English**)* **Additional** (specific**) methods and characteristics**[2] used in delivering the knowledge *(if any)*: -	
Assessment Method (Exam / Midterm Grade / **Other**[3]): colloquium **Additional** (specific) **methods**[4] applied in knowledge assessment *(if any)*: -	
Course Placement in Curriculum (Semester Number): spring semeter	
Prerequisites (*if any*): -	

Course Description: **A concise yet informative description of the knowledge** to be acquired.

Goals of 3D computer vision. Modeling of spatial objects. Scene reconstruction from images and other modalities (shape from X). Motion analysis, motion-based reconstruction. Structure from motion. Recognition, detection, position estimation, texture analysis. Mathematical background: numerical methods, Affine transformations, projective geometry, Linear algebra, singular value decomposition. Principal Component Analysis (PCA). Probability theory. RANSAC, Least Median of Squares, Least Trimmed Squares. Kalmanfiltering. Digital image processing. Resolution and scale, scale space. Camera models: orthogonal, perspective, weak-perspective cameras. Intrinsic and extrinsic parameters, camera calibration. Local image features, lines, curves. Detection of edges, lines and corners. Canny edge detection, Hough transformation. Active contours. Stereo vision, correspondences. 3D reconstruction, sparse matching. Feature matching: correlation-based methods, epipolar geometry, fundamental matrix. Estimation of fundamental and essential matrices. Occlusion and noise handling. Robust methods, rectification, dense matching. Triangulation, Projective, affine and metric reconstruction. Special reconstruction methods: shape from shading, photometric stereo, shape from texture. Active methods. Shape from contours. Reconstruction by Structured light and laser. Range images, Point registration, ICP algorithm and its robust variants. Motion analysis: motion of rigid objects. Optical flow, normal flow. Constraints for motion. Estimation of optical flow. Motion tracking based on feature points. Kanade-Lucas-Tomasi (KLT) tracker. Motion-based object reconstruction, Tomase-Kanade factorization. Kalman filter. Recognition, invariants, appearance-based methods, visual eigenspaces, model-based recognition and positioning, alignment of points and lines, position estimation in perspective and weak-perspective cases. Industrial computer vision application: installation, quality control. Reverse engineering, medical image processing (MRI, CT). Attention and security. Human motion detection and modeling, traffic control, intelligent robots and vehicles, realistic modeling of artistic objects.

2-5 Most Important Required and Recommended Literature
List of required and recommended literature (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).

E.Trucco, A.Verri, Introductory Techniques for 3-D Computer Vision, Prentice Hall, 1998.

M.Sonka, V.Hlavac, R.Boyle, Image Processing, Analysis and Machine Vision, PWS Publishing, 2nd edition, 1999.
R.Hartley, A.Zisserman, Multiple View Geometry in Computer Vision, Cambridge University Press, 2000.

Lecture notes
https://cv.inf.elte.hu/index.php/education/3d-computer-vision/
https://cv.inf.elte.hu/index.php/education/3d-sensing-and-sensor-fusion/

List of Prescribed Professional Competencies and Competency Elements

(knowledge, skills, etc., KKK Section 8) that the course significantly contributes to developing (highlight the most important ones).

a) Knowledge

- Has a research-level understanding of the general and specific characteristics, major directions, and precisely developed boundaries of the subject area within the discipline, as well as the agreed and debated interrelations.
- Creatively comprehends the interrelations, theories, and conceptual frameworks and terminologies of the given field of study.[1]
- Possesses research methodology knowledge necessary for independent research in the given discipline/field.

b) Skills

- Capable of creative analysis of the field, synthesizing comprehensive and specific interrelations with a new perspective, and conducting appropriate evaluative and critical activities.
- Able to apply and further develop the specialized learning and problem-solving methods of the field.
- Can creatively elaborate on the novel, previously unknown practical implications of theoretical issues.
- Capable of planning and executing new projects, conducting research in the field, and developing new techniques and approaches.
- Able to identify unforeseen professional problems and uncover the detailed theoretical and practical background necessary for their resolution at a research level.
- Can construct and communicate new relations relevant to the field, as well as comprehensive interrelations significant for personal and communal existence.

c) Attitudes

[1] **Section 108**, Article 37 of the National Curriculum Act (Nftv.) 37. lesson: a session (lecture, seminar, exercise, consultation) requiring the personal involvement of the instructor to fulfil the academic requirements specified in the curriculum, the duration of which is at least forty-five minutes and not more than sixty minutes.
[2] e.g. case studies, role play, thematic presentations, etc.
[3] e.g. continuous debriefing, mid-year report
[4] e.g. request for case studies, thematic papers, essays, business, organisational plans, etc.

- Represents and further develops the relations that contribute to the process of human self-creation based on the field's characteristics.
- Possesses an interest and learning ability that enable identifying and solving currently unpredictable research problems in the field.
- Demonstrates a firm professional commitment, a continuous dedication to exploring new approaches, and an acceptance of the necessity for persistent effort.

d) Autonomy and Responsibility

- Builds and initiates new knowledge areas with creative independence and proposes new practical solutions.
- Participates in formulating theoretical and practical questions with a leadership role and high-level cooperation.
- Engages as an equal discussion partner with professionals in the field.
- Takes responsibility for raising and addressing new ethical questions concerning theoretical and practical aspects of the profession.

Course responsible (name, position, academic degree): **Dr. Levente Hajder, associate professor**

Instructor(s) involved in teaching the course (if any) (name, position, academic degree):
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