PhD subject:

Learning and Representing 4D Human Data

Hosting institute

ICube Laboratory (Le laboratoire des sciences de l'ingénieur, de l'informatique et de l'imagerie : The Engineering science, computer science and imaging laboratory) at the University of Strasbourg is a leading research center in Computer Science, with more than 300 permanent researchers, with the recently opened AI graduate school supported by the French government.

Work place and salary

The PhD will take place in CAID (Computer-Aided Intervention & Design, 2021–) research team located at the hospital site, 10 min walking distance to the city center of Strasbourg, which is a UNESCO world heritage site.

Salary: 1,500€/month approximately for a duration of 36 months (2021 - 2024).

Funding source

l'Agence Nationale de la Recherche (ANR, French National Research Foundation): PRC (Collaborative Research Project) Human4D project.

Staring date

Any time in 2021, with a preference for January/February.

Supervisors

director: Hyewon Seo (ICube, Univ. Strasbourg), co-supervisor: Cédric Bobenrieth (ICube, ECAM)

Context

Reconstructing, characterizing, and understanding the shape and motion of individuals or groups of people have many important applications, such as ergonomic design of products, rapid reconstruction of realistic human models for virtual worlds, and an early detection of abnormality in predictive clinical analysis.

Recent evolutions in the technology for capturing moving shapes enable now full 4D models of human shapes including geometry, motion and appearance, as in Inria [Kino], MPI [DAST+08], or more recently with commercial platforms deployed by Intel [Ints] or Microsoft [Holo]. Such data open new possibilities and challenges for the analysis and the synthesis of human shapes in motion that are yet largely unexplored but would be of benefit to a wide range of applications. This is especially true with the rapidly growing VR/AR immersive applications, which require realistic and detailed models to improve the immersive experience. Magic leap, Microsoft Hololense, and Facebook Oculus Rift, among others, are clear examples of this recent and rapid evolution and the associated need to produce adapted realistic contents. In the future we will be able to make digital copies of moving persons using a handy imaging device, send them over the network, and make customized compositions of the retrieved 4D human data in our daily life. The French national project Human4D aims at contributing to this evolution with objectives that can profoundly improve the reconstruction, transmission, and reuse of digital human shape data, by unleashing the power of recent deep learning techniques and extending it to 4D human shape modeling.

PhD objectives

The objective of this thesis is to develop compact representations of 4D human data that recent deep neural networks can learn over, and demonstrate illustrative applications that are able to analyze, recover, and synthesize 4D human models.

Research in computer vision and artificial intelligence has achieved disruptive results in the recognition and synthesis of objects in the image by means of large annotated datasets, deep learning algorithms and adequate GPU resources. However, with most existing architectures and algorithms having developed for 2D images, their adaptation to 3D data (point clouds or meshes) is less obvious, where a regular structure is not directly available. While DL CNNs have been used in some 3D contexts, e.g. face [TZK+17,TL18, RBSB18] or body modeling [DJOZ+17], their interest in live modeling of complex, articulated shapes like human body has not yet been fully explored, and extending the learning ability to 4D context remains a largely unexplored area.

The specific goal of this work is therefore to propose a new, efficient 4D shape modelling framework for human body shapes under motion, going beyond existing shape space representations that mostly focus on static shape poses and seldom consider the continuous dynamics of body shapes. This will be implemented by leveraging recent deep learning strategies for modeling controllable yet non-deterministic shape changes on one hand, and by investigating novel solutions to several related problems on the other hand, including space-time segmentation [LCS16] and correspondence [MSC15], nonlinear dimensionality reduction.

Candidate profile

— Master degree in Computer Science or in (Applied) Mathematics
— Solid programming skills in Python/Matlab
— Solid knowledge in deep learning with programming experience in Tensorflow or Pytorch
— Working knowledge in geometry modeling and statistics
— Good communication skills

Application

Please send your CV, academic transcriptions (undergraduate and master courses with rankings) and one or more recommendation letters to seo@unistra.fr.

References

[DAST+08] E. De Aguiar, C. Stoll, C. Theobalt, N. Ahmed, H.-P. Seidel, S. Thrun: Performance capture from sparse multi-view video, ACM Trans. Graphics (Proc. ACM SIGGRAPH 2008).

[DJOZ+17] Dibra, Endri & Jain, Himanshu & Oztireli, Cengiz & Ziegler, Remo & Gross, Markus. (2017). Human Shape from Silhouettes Using Generative HKS Descriptors and Cross-Modal Neural Networks. 5504-5514. 10.1109/CVPR.2017.584.

[Holo] https://www.microsoft.com/en-us/mixed-reality/capture-studios.

[Ints] Intel Studios, Los Angeles.

[Kino] http://kinovis.inrialpes.fr

[LCS16] G. Luo, F. Cordier, and H. Seo: Spatio-temporal Segmentation for the Similarity Measurement of Deforming Meshes, The Visual Computer, Vol.32, No.2, pp.243-256, Springer, 2016.

[MSC15] V. Mykhalchuk, H. Seo, F. Cordier: On Spatio-Temporal Feature Point Detection for Animated Meshes, The Visual Computer, Springer, 31(11), pp. 1471-1486, 2015.

[RBSB18] Generating 3D faces using convolutional mesh autoencoders, A Ranjan, T Bolkart, S Sanyal, MJ Black Proc. European Conference on Computer Vision (ECCV), 704-720, 2018.

[TZK+17] A. Tewari, M. Zollhofer, H. Kim, P. Garrido, F. Bernard, P. Perez, C. Theobalt: MoFA: Model-Based Deep Convolutional Face Autoencoder for Unsupervised Monocular Reconstruction. Int'l Conf. Computer Vision 2017.

[TL18] L. Tran, X. Liu: Nonlinear 3D Face Morphable Model. IEEE Conf. IEEE Conf. Computer Vision and Pattern Recognition, 2018.