PhD position

Title:

Efficient representation of discrete dynamic contents for augmented reality

Position type: PhD student
Functional area: Nantes
Team: IPI Image Perception Interaction
Scientific advisors: vincent.ricordel@univ-nantes.fr and nicolas.normand@univ-nantes.fr
Application deadline: 15th of May 2017
Duration: 36 months
Starting date: 1st of September 2017
Net salary: 1430 euros per month (funds from the French Ministry for the Research)

About LS2N and the IPI team

The **LS2N** "Laboratoire des Sciences du Numériques de Nantes" (www.ls2n.fr) is a new joint research unit associated with CNRS, it has been created in January 2017, and it results from the merge of the IRCCyN and LINA laboratories. The LS2N aims to bring together the research forces of Nantes in Cybernetics and Computer Sciences, in order to develop the digital sciences, opened to the other disciplines and in an awareness of the societal challenges that it implies. The LS2N is supported by 5 co-tutelles and partners (University of Nantes, CNRS, Ecole Centrale de Nantes, IMT Atlantique, and INRIA), it counts about 450 researchers and it is located on 5 geographical sites in Nantes.
Within the LS2N, the **IPI** "Image Perception Interaction" (www.ls2n.fr/equipe/ipi) team is the new version of the IVC team. The IPI team belongs to the SIEL cluster "Signal, Images, Ergonomics, Languages" of the LS2N, and IPI contributes to 3 transversal themes of the laboratory (Enterprise of the Future, Life Sciences, Digital Creation, Culture and Society). Exactly the research of the IPI team is grouped around five themes: Discrete representation of the information; Representation and perception (psycho-visual models); Interaction and perception (image quality and Quality of Experience); Multimedia representation and communication; Interpretation (learning and pattern recognition for structured handwritten documents).

PhD Subject:

Virtual Reality (VR) and **Augmented Reality (AR)** are announced as the next digital technologies that, after those of the Web and Mobile, will revolutionize our modes of communication [1-2]. VR and AR are therefore at the heart of many researches, and in particular those in video compression. Indeed, if on one side of the communication chain, the contents emerge with 360 acquisition systems for VR (e.g. Nokia Ozo camera, Facebook Surround) and studio capture for AR. And if on the other side of the chain, visual rendering systems are numbered with the Head Mounted Display HMD (e.g. Oculus Rift, HTC Vive, Playstation VR for the RV, HoloLens for the AR). At the heart of the chain remains the need to find an efficient representation of content, in order to compress them while preserving their characteristics. At this level, the immersion experiences offered by the RV (typically the dynamic discovery of a panoramic scene) and AR (typically a roaming within a 3D scene) are different; the representations of the contents and the coding approaches will be therefore also distinguished [3].
We will be interested for this PhD particularly by AR approaches, where the data of the 3D kinematic contents are volumetric. Their representations are typically done by **light field, or by dynamic mesh, or by dynamic point cloud**. These **volumetric representations** are heavy (e.g the data mass of a light field scene is 100 times larger than a traditional 2D video), and very far from those of the classic videos. So that MPEG compression standards

cannot be applied (it can be noted at this level that MPEG is interested in the compression of contents VR [4**]). For AR contents, new compression approaches are therefore necessary** [5-6], and it is necessary too to adapt the processing models, for example to estimate / compensate the motion, to optimize the rate / distortion compromise, to evaluate the distortions, or to define scalable flows [7-10]. Research also focuses on redefining and generalizing conventional signal processing operations (transformation, frequency analysis, filtering, interpolation, sampling, etc.) to apply them to these dynamic volumetric representations where information can be modeled as graphs [11-12]. There is therefore a wide scope for **discrete geometry**.

Bibliography:

[1] Apostolopoulos, J. G., Chou, P. A., Culbertson, B., Kalker, T., Trott, M. D., & Wee, S. (2012). The road to immersive communication. Proceedings of the IEEE, 100(4), 974-990.

[2] Digi-Capital, Augmented/Virtual Reality revenue forecast revised to hit $120 billion by 2020, http://www.digi-capital.com/news/2016/01/augmentedvirtual-reality-revenue-forecast-revised-to-hit-120-billion-by-2020/

[3] Dagiuklas, T. (2015). Novel 3D Media Technologies. A. Kondoz (Ed.). Springer.

[4] Lafruit, G., Quackenbush, S., Foessel, S., & Hinds, A. (2016). Technical report of the joint ad hoc group for digital representations of light/sound fields for immersive media applications.

[5] Nguyen, Chou, and Chen, "Compression of Human Body Sequences Using Graph Wavelet Filter Banks," ICASSP 2014

[6] Anis, Chou, and Ortega, "Compression of Dynamic 3D Point Clouds using Subdivisional Meshes and Graph Wavelet Transforms," ICASSP 2016

[7] Thanou, Chou, and Frossard, "Graph-based compression of dynamic 3D point cloud sequences," TIP 2015

[8] Queiroz and Chou, "Compression of 3D Point Clouds Using a Region-Adaptive Hierarchical Transform," TIP 2016

[9] Queiroz and Chou, "Motion-Compensated Compression of Dynamic Voxelized Point Clouds," TIP 2016

[10] Huang, Peng, Kuo, and Gopi, "A generic scheme for progressive point cloud coding,"
IEEE Trans. Vis. Comput. Graph., 2008

[11] Shuman, Narang, Frossard, Ortega, and Vendergheynst, "Signal Processing on Graphs," IEEE Signal Processing Magazine, May 2013.

[12] A. Sandryhaila and J. M. F. Moura, "Discrete signal processing on graphs," IEEE Transactions on Signal Processing, vol. 61, no. 7, pp.1644-1656, 2013

Skills and profile:

Master computer science, data science, signal/image processing or applied maths. Excellent ranking in Master is necessary. Additional knowledge on image/video coding, discrete geometry and programming is a plus. Fluency in English is an important added value.

Contact:

Send your CV, motivations and Master's scores and ranking to Vincent Ricordel (vincent.ricordel@univ-nantes.fr) before the 15th of May 2017.