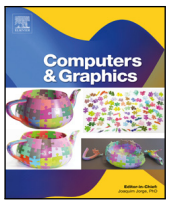
Computers & Graphics 122 (2024) 103865

Contents lists available at ScienceDirect

Computers & Graphics

journal homepage: www.elsevier.com/locate/cag



Editorial

Foreword to the special section on 3D object retrieval 2023 symposium (3DOR2023)

This special section of Computers & Graphics (C&G), features the full papers presented at the 16th Eurographics Symposium on 3D Object Retrieval — 3DOR 2023 (https://sites.google.com/view/3dor2023/home). 3DOR was hosted by CRIStAL (Research center in Computer Science, Signal and Automatic Control of Lille) on August 31–September 1, 2023. Virtual attendance at the workshop was possible for presenters who had health issues or in traveling problems.

The 3DOR series aims to stimulate researchers from different fields such as Computer Vision, Computer Graphics, Machine Learning, Cognitive Science and Human–Computer Interaction who are interested in 3D object retrieval, recognition and exploration, to present state-of-the-art work in the field of or learn about it and participate in discussions. It provides a cross-fertilization that stimulates a broader forum of discussions on the next steps in this important research area.

In addition, the Shape Retrieval Contest (SHREC) runs alongside 3DOR, and is an established venue for benchmarking the effectiveness of new and existing methods in 3D shape retrieval. This involves building or acquiring test collections and comparing and evaluating 3D retrieval methods. SHREC is an important part of 3DOR, and it can be seen that about half of this special issue consists of these evaluation papers.

We were pleased to have three keynote speakers this year at 3DOR.

Dr. Stefanie Wuhrer, research scientist of Morpheo team at Inria centre of the University Grenoble Alpes (France), gave a keynote talk on "Learning representations of 4D human motion" in which she presented recent results on data-driven representations and analyses of full human body motion focusing on human motion retargeting and on learned representations of 4D human motion.

Prof. Maks Ovsjanikov, professor at Ecole Polytechnique (France), presented his keynote talk on "Efficient, general-purpose feature learning for 3D shape comparison" giving an overview of several recent advances in learning features for rigid and non-rigid 3D shapes showing how robust and accurate pointwise features on deformable shapes can be learned in an unsupervised manner and discussing how generalizable feature pre-training can be done on complex scenes and then used in downstream tasks involving completely unseen classes.

Prof. Angela Dai, professor at the Technical University of Munich (Germany), gave a keynote talk on "Learning from synthetic 3D priors for real-world 3D perception" in which she presented how to leverage structural and object priors from large-scale synthetic shape and scene datasets to form a basis for understanding object structures from commodity RGB and RGB-D sensors and discussing the possibilities to learn from weaker supervision signals, along with future challenges in object-based reconstruction and tracking.

The full paper submission track followed a 2-stage review process, with accepted papers being published directly in Computers & Graphics. A second call for submissions of short papers took place and a selection of these papers was published in the Eurographics Digital Library.

15 papers were submitted to the full paper track, out of which 12 were accepted for publication in Computers & Graphics; 2 of these papers applied and received the Replicability Badge issued by the Graphics Replicability Stamp Initiative (GRSI). Of these 12 papers, 9 were research papers while 3 were the outcome of SHREC tracks.

Research full papers (9).

To face the data inconsistencies occurring in 3D generative model leading to unregistered meshes or point clouds, [1] proposes an architecture able to cope with different parameterizations and a loss function, built upon a kernel-based metric over a representation of meshes using geometric measures, allowing for implementing an efficient dissimilarity measure with many desirable properties such as robustness to resampling of the mesh or point cloud. In [2], a Spectral Transformer for 3D triangular Human Mesh Sequence learning (SpecTrHuMS) is presented. It combines known deep learning models with spectral mesh processing to capture characteristics of 3D shapes as well as temporal dependencies between the frames. A novel approach based on Graph Neural Networks for 3D mesh relief pattern classification is proposed in [3]. The network adopts a bi-level architecture that learns on data structures computed thanks to a mesh resampling algorithm that allows us to represent local surface patches uniformly, while keeping a consistent points order. In [4], a novel neural object representation, called Medial Atom Ray Fields (MARFs), is presented. It enables accurate differentiable surface rendering with a single network evaluation per camera ray overcoming typical limitations of existing neural ray fields which struggle with multi-view consistency and representing surface discontinuities. The development of a tool for 3D reconstruction deploying methods such as physically-based differentiable rendering (PBDR) and inverse rendering is achieved in [5]. This approach requires fewer viewpoints, yields explicit format results, and ensures a smoother transition to other representation methods. Despite voltage-gated sodium (Nav) channels constitute a prime target for drug design and discovery, this research field is lacking of accurate and comprehensive geometric information resources. To fill this gap, [6] presents a geometric dataset of molecular surfaces that are representative of Nav channels in mammals. For each structure, multiple representations and a number of geometric measures are provided and the effective use of the dataset is experimentally tested. C2SPoint [7] is a classification-to-saliency network for point cloud saliency detection. This novel weakly supervised classification network aims at supporting downstream tasks in 3D graphics and vision and it overcomes existing approaches often relying on hand-crafted features and only applicable to specific datasets. In [8], the potential of self-supervised learning as an alternative to supervised learning in the context of geometry-based 3D object retrieval is investigated. Extensive experiments are

https://doi.org/10.1016/j.cag.2023.12.007
11 December 2023
Available online 13 December 2023

performed putting in direct comparison supervised and self-supervised learning on four datasets from three different domains. The achieved results allow for concluding that self-supervised learning provides a powerful tool for circumventing labeling costs and providing more robust retrieval systems. SketchCADGAN [9] is a generative approach for completing partially drawn query sketches of engineering shapes to enhance retrieval system performance. This network uses a two-stage cascaded architecture, attempting to predict a CAD model image from an incomplete sketch and using the CAD model image to predict a completed sketch. Qualitative and quantitative comparisons are performed proving that the proposed approach is more effective than other advanced techniques.

SHREC full papers (3).

In [10], a novel SHREC challenge related to the retrieval of 3D object is proposed. Specifically, the track focuses on retrieving relevant 3D animal models from a dataset using sketch queries and expedites accessing 3D models through available sketches. To this end, a new dataset named ANIMAR was constructed, comprising a collection of 711 unique 3D animal models and 140 corresponding sketch queries. The challenge received satisfactory results from eight teams and 204 runs allowing for concluding that the proposed task has the potential to incentivize additional research in the domain of 3D object retrieval, potentially yielding benefits for a wide range of applications The SHREC challenge track presented in [11] focuses on text-based fine-grained retrieval of 3D animal models. The proposed task requires participants to develop innovative approaches to tackle the problem of text-based retrieval. Five groups participated in the competition, submitting a total of 114 runs. While the obtained results are satisfactory, the challenges presented by this task are far from fully solved providing insights for future research and improvements. In [12], the SHREC challenge track provides a city-scene dataset with real and synthesized data to detect 3D point cloud change. The dataset consists of 866 pairs of object changes from 78 city-scene 3D point clouds collected by LiDAR and 845 pairs of object changes from 100 city-scene 3D point clouds generated by a high-fidelity simulator. The three participating methods are compared on this benchmark revealing that data-driven methods are the current trend in 3D point cloud change detection and that the siamese network architecture is helpful in detecting changes in our dataset.

We thank the IPC members for their reviewing efforts, which helped us to create a high-quality program and led to the success of this special section. We also thank the Eurographics Association for their continued support, CRIStAL laboratory for hosting the event, the 3DOR endowment for partially contributing towards the author fees, Stefanie Behnke (EG publishing) for her support in managing the workshop, and, of course, Abigail Campbell, Elsevier journal manager, and Joaquim Jorge, editor-in-chief of C&G for making this C&G Special Section possible.

Workshop chairs
Mohamed Daoudi, IMT Nord Europe, France
Silvia Biasotti, IMATI-CNR, Genova, Italy

Programme chairs
Ulderico Fugacci, IMATI-CNR, Genova, Italy
Guillaume Lavoué, Centrale Lyon, CNRS, France
Remco Veltkamp, Utrecht University, The Netherlands

Best paper award committee
Ulderico Fugacci, IMATI-CNR, Genova, Italy
Guillaume Lavoué, Centrale Lyon, CNRS, France
Ioannis Pratikakis, Democritus University of Thrace, Greece

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

References

[1] Besnier T, Arguillère S, Pierson E, Daoudi M. Toward mesh-invariant 3D generative deep learning with geometric measures. Comput Graph 2023;115:309–20. http://dx.doi.org/10.1016/j.cag.2023.06.027.
[2] Lemeunier C, Denis F, Lavoué G, Dupont F. SpecTrHuMS: Spectral transformer for human mesh sequence learning. Comput Graph 2023;115:191–203. http://dx.doi.org/10.1016/j.cag.2023.07.001.
[3] Guiducci N, Tortorici C, Ferrari C, Berretti S. Learning graph-based features for relief patterns classification on mesh manifolds. Comput Graph 2023;115:69–80. http://dx.doi.org/10.1016/j.cag.2023.07.004.
[4] Sundt PB, Theoharis T. MARF: The medial atom ray field object representation. Comput Graph 2023;115:122–36. http://dx.doi.org/10.1016/j.cag.2023.06.032, URL https://www.sciencedirect.com/science/article/pii/S0097849323001279.
[5] Yılmaz D, Kıraç F. Illumination-guided inverse rendering benchmark: Learning real objects with few cameras. Comput Graph 2023;115:107–21. http://dx.doi.org/10.1016/j.cag.2023.07.002.
[6] Raffo A, Fugacci U, Biasotti S. GEO-nav: A geometric dataset of voltage-gated sodium channels. Comput Graph 2023;115:285–95. http://dx.doi.org/10.1016/j.cag.2023.06.023.
[7] Jiang Z, Ding L, Tam GK, Song C, Li FW, Yang B. C2SPoint: A classification-to-saliency network for point cloud saliency detection. Comput Graph 2023;115:274–84. http://dx.doi.org/10.1016/j.cag.2023.07.003.
[8] Van den Herrewegen J, Tourwé T, wyffels F. Self-supervised learning for robust object retrieval without human annotations. Comput Graph 2023;115:13–24. http://dx.doi.org/10.1016/j.cag.2023.06.029.
[9] Kendre PP, Kosalaraman KK, Jayasree SSK, Rajan S, Jayan A, Muthuganapathy R. Sketchcadgan: A generative approach for completing partially drawn query sketches of engineering shapes to enhance retrieval system performance. Comput Graph 2023;115:55–68. http://dx.doi.org/10.1016/j.cag.2023.06.028.
[10] Le T-N, Nguyen TV, Le M-Q, Nguyen T-T, Huynh V-T, Do T-L, Le K-D, Tran M-K, Hoang-Xuan N, Nguyen-Ho T-L, Nguyen V-T, Le-Pham N-Q, Pham H-P, Hoang T-V, Nguyen Q-B, Nguyen-Mau T-H, Huynh T-L, Le T-D, Nguyen-Ha N-L, Truong-Thuy T-V, Phong TH, Diep T-N, Ho K-D, Nguyen X-H, Tran T-P, Yang T-A, Tran K-P, Hoang N-V, Nguyen M-Q, Vo H-D, Doan M-H, Nguyen H-D, Sugimoto A, Tran M-T. SketchANIMAR: Sketch-based 3D animal fine-grained retrieval. Comput Graph 2023;116:150–61. http://dx.doi.org/10.1016/j.cag.2023.07.035.
[11] Le T-N, Nguyen TV, Le M-Q, Nguyen T-T, Huynh V-T, Do T-L, Le K-D, Tran M-K, Hoang-Xuan N, Nguyen-Ho T-L, Nguyen V-T, Diep T-N, Ho K-D, Nguyen X-H, Tran T-P, Yang T-A, Tran K-P, Hoang N-V, Nguyen M-Q, Nguyen E-R, Nguyen-Nhat M-K, To T-A, Huynh-Le T-T, Nguyen N-T, Luong H-C, Phong TH, Le-Pham N-Q, Pham H-P, Hoang T-V, Nguyen Q-B, Nguyen H-D, Sugimoto A, Tran M-T. Textanimar: Text-based 3D animal fine-grained retrieval. Comput Graph 2023;116:162–72. http://dx.doi.org/10.1016/j.cag.2023.07.026.
[12] Gao Y, Yuan H, Ku T, Veltkamp RC, Zamanakos G, Tsochatzidis L, Amanatiadis A, Pratikakis I, Panou A, Romanelis I, Fotis V, Arvanitis G, Moustakas K. SHREC 2023: Point cloud change detection for city scenes. Comput Graph 2023;115:35–42. http://dx.doi.org/10.1016/j.cag.2023.06.025.

Silvia Biasotti is a Research Director at the Institute of Applied Mathematics and Information Technologies of the National Research Council of Italy (CNR-IMATI). Her research interests include shape modeling, similarity reasoning with incomplete or partial information, pattern, color and texture recognition on surfaces, change detection on 3D data, and the exploration of large collections of 3D models. She was in charge of several CNR-IMATI research activities on surface similarity reasoning and is involved in the creation of datasets and benchmarks; in particular, she organized several tracks of the SHape REtrieval Contest (SHREC). More details are available at https://imati.cnr.it/mypage/people/BiasottiSilvia.htm.

Mohamed Daoudi is a full professor of Computer Science at IMT Nord Europe and the lead of Image group at CRIStAL Laboratory (UMR CNRS 9189). His research interests include pattern recognition, shape analysis, and computer vision. He has published over 150 papers in some of the most distinguished scientific journals and international conferences and supervised 28 Ph.D. theses. He is/was Associate Editor of Image and Vision Computing Journal, IEEE Trans. on Multimedia, Computer Vision and Image Understanding, IEEE Trans. on Affective Computing, Computers & Graphics, and Journal of Imaging. He is a Fellow of IAPR. For more information, visit http://www.cristal.univ-lille.fr/~daoudi.

Ulderico Fugacci is a Researcher at the Institute of Applied Mathematics and Information Technologies of the National Research Council of Italy (CNR-IMATI). His research interests include various topics related to Algebraic Topology, Computational Geometry and Commutative Algebra. Specifically, he focuses his studies on Topological Data Analysis. For more information, visit https://imati.cnr.it/mypage/people/FugacciUlderico.htm.

Guillaume Lavoué is a full professor at ENISE, École Centrale de Lyon, France. He is a member of the LIRIS CNRS lab, and head of the ENISE virtual reality research team. His research focuses on computer graphics, virtual reality, and human perception. He has co-authored more than 100 international publications in peer-reviewed journals and conferences. For more information, visit https://perso.liris.cnrs.fr/guillaume.lavoue/.

Remco C. Veltkamp, is full professor of Game and Media Technology at Utrecht University, The Netherlands. His research topics are the analysis, recognition and retrieval of, and interaction with, 3D objects and scenes, images, video, music, and games. His interests are in particular the algorithmic and experimentation aspects, with a special focus on game research. He is director of the Utrecht center for Game Research, http://www.gameresearch.nl/, he has published over 280 refereed papers in journals and conferences, and supervised 30 Ph.D. theses.

Silvia Biasotti *
Istituto di Matematica Applicata e Tecnologie Informatiche "E. Magenes" - CNR, Italy
E-mail address: silvia.biasotti@ge.imati.cnr.it.

Mohamed Daoudi
IMT Nord Europe, Institut Mines-Télécom, Univ. Lille, Centre for Digital Systems, Lille, F-59000, France
Univ. Lille, CNRS, Centrale Lille, Institut Mines-Télécom, UMR 9189 CRIStAL, Lille, F-59000, France
E-mail address: mohamed.daoudi@imt-nord-europe.fr.

Ulderico Fugacci
Istituto di Matematica Applicata e Tecnologie Informatiche "E. Magenes" - CNR, Italy
E-mail address: ullderico.fugacci@ge.imati.cnr.it.

Guillaume Lavoué
Univ Lyon, Centrale Lyon, CNRS, LIRIS, UMR5205, ENISE, F-42023 Saint Etienne, France
E-mail address: guillaume.lavoue@enise.ec-lyon.fr.

Remco C. Veltkamp
Department of Information and Computing Sciences, Utrecht University, The Netherlands
E-mail address: R.C.Veltkamp@uu.nl.

* Corresponding editor.