



HAL
open science

Un design space de vidéos augmentées de matches de tennis de table

Aymeric Erades, Anais Servais, Christophe Hurter, Romain Vuillemot

► **To cite this version:**

Aymeric Erades, Anais Servais, Christophe Hurter, Romain Vuillemot. Un design space de vidéos augmentées de matches de tennis de table. Journée Visu, 2024. hal-04617611

HAL Id: hal-04617611

<https://hal.science/hal-04617611v1>

Submitted on 19 Jun 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Un design space de vidéos augmentées de matches de tennis de table

Aymeric Erades, Anais Servais, Christophe Hurter and Romain Vuillemot

English Abstract—We present a preliminary work on the design space of sports video augmentation techniques, following ecological design principles. The goal is to enable novel videos designs that increase viewing engagement for both sports fans and casual viewers. We hypothesize such augmentation techniques are efficient as they are both embedded with close relationships to the physical scene and sport events, but also are based on visual channels from the video (brightness, motion). This approach differs from current video augmentation techniques that replicate TV broadcast practices or use traditional, geometric-based visualization marks. In this paper we introduce the underlying design space behind those techniques issued from a comprehensive review of visual and physical effects. We report on the main dimensions we identified, and preliminary videos we have generated from it.

1 INTRODUCTION

Augmenting sports videos is an active trend in the visualization community [4] [14] [13] [12]. This is permitted due to recent advances in computer vision and deep learning models [3] in particular adapted for sports events detection and classification [10]. Thus video effects reaching the same quality than on TV broadcasts or video editing tool can be embedded in sports video, automatically without requiring any video editing skill. Examples of such effects are players segmentation and highlighting, spotlight effects and slow motion based on events. Also, since those techniques are data-driven, they often operate at a finer, more detailed spatial and temporal level than when done manually (to segment players masks). Such augmentation provide a more closer way to understand and analyze table tennis techniques and tactics than abstract shot maps [6].

This paper contributes to a better understanding of the underlying design space of such augmented videos. We introduce to a design space, that follows *ecological* principles from Gibson [8] perception theory that states an environment has inherent properties that are closely related to the actions (he refers to as affordance). We illustrate our approach with a preliminary implementation of the technique and discuss the next step of this research.

2 DESIGN SPACE

We identified the design space by following ecological principles. It will be organized around orthogonal

- Aymeric Erades: École Centrale de Lyon, CNRS, UMR5205, LIRIS, France; E-mail: aymeric.erades@ec-lyon.fr.
- Anais.Servais@uliege.be: Université de Liege, Belgique; E-mail: anais.servais@hotmail.com.
- Christophe Hurter: ENAC, France; E-mail: christophe.hurter@enac.fr
- Romain Vuillemot: École Centrale de Lyon, CNRS, UMR5205, LIRIS, France; E-mail: romain.vuillemot@ec-lyon.fr.



Fig. 1. Example of augmented video: the ball bouncing location and region are emphasized with graphical marks. Video playback speed (not visible on the above screenshot) also adapts to players hits.

dimensions and non-orthogonal ones. The first dimension will be about natural **localization** of objects, such as players or balls. This will enable to grasp the scene structures with the involved actors (players), as well as the relevant moving objects (ball) and instruments (rackets, table). The second will be about movement **recognition** to better grasp the nature of movements, for table tennis it will be related to strokes (serve, forehand strokes). The third dimension will be around **emphasis** that augments an already present in the scene, but is not noticeable enough to be clearly perceived.

From this design space, we will associate data and physical stimuli. Data will be the trigger for those dimensions to be used in a relevant spatial and temporal context, with the appropriate level of magnitude. This level of magnitude is not expect to be binary, but rather a progressing function of interest [7] to smoothly transition from no stimuli to

full stimuli. Regarding such stimuli, we expect to both use standard grammar of graphics from Bertin [1] and Wilkinson [11]. But we will include more ecologically valid stimuli that Gibson refers to as *visual affordances*, which are perceivable cues to encode the design dimensions in a non-intrusive way. To explore this space, we have collected multiple sports video with embedded special effects and we found that the use of lights, shadows, zoom levels, camera motion and video playback speed are the most common ones.

Such results are preliminary and we expect to conduct a formative study that clearly identify, detail those dimensions, along with mapping to physical stimuli we identified.

3 PRELIMINARY RESULTS AND FUTURE WORK

Fig. 1 shows an example of such video generated using detailed tracking data [9] which are the currently most accurate level of sports data analysis. We recorded ourselves such videos, but any video could have been used (assuming the camera is static so a scene understanding is enabled). We collected video data using a combination of automated human pose tracking [3], with a combination of manually detected events. The generation process is then automated (assuming data are available) for any table tennis video. Thus a complete game can now be experienced with such augmentations.

This first technique is not only a proof of concept with simple position and events, but will be refined with additional augmentations and we plan to conduct a user study to assess its effect compared to non-augmented videos. We will conduct design explorations and the use of more complex data, tactics [5] or domination factors [2]. We also plan to release the code to generate such videos as an open source project so further research can be conducted in this area.

REFERENCES

- [1] J. BERTIN. *Sémiologie graphique: les cartes, les diagrammes, les réseaux*. Paris-La Haia: Mouton-Gautier Villars, 1973.
- [2] G. Calmet, A. Erades, and R. Vuillemot. Exploring Table Tennis Analytics: Domination, Expected Score and Shot Diversity. In S. Link, editor, *Machine Learning and Data Mining for Sports Analytics*, Communications in Computer and Information Science, Turin, Italy, Sept. 2023.
- [3] Z. Cao, G. Hidalgo, T. Simon, S.-E. Wei, and Y. Sheikh. OpenPose: Realtime Multi-Person 2D Pose Estimation Using Part Affinity Fields. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 43(1):172–186, Jan. 2021.
- [4] Z. Chen, Q. Yang, X. Xie, J. Beyer, H. Xia, Y. Wu, and H. Pfister. Sporthesia: Augmenting Sports Videos Using Natural Language. *IEEE transactions on visualization and computer graphics*, Jan. 2022.
- [5] P. Duluard, X. Li, M. Plantevit, C. Robardet, and R. Vuillemot. Discovering and Visualizing Tactics in a Table Tennis Game Based on Subgroup Discovery. In *Machine Learning and Data Mining for Sports Analytics*, volume 1783, pages 101–112. Springer Nature Switzerland, Cham, 2023.
- [6] A. Erades and R. Vuillemot. Visual Analysis of Table Tennis Game Tactics. *Journée Visu 2023*, June 2023.
- [7] G. W. Furnas. Generalized fisheye views. *ACM SIGCHI Bulletin*, 17(4):16–23, Apr. 1986.
- [8] J. J. Gibson. *The Ecological Approach to Visual Perception: Classic Edition*. Houghton Mifflin, 1979.
- [9] C. Perin, R. Vuillemot, C. D. Stolper, J. T. Stasko, J. Wood, and S. Carpendale. State of the Art of Sports Data Visualization. *Computer Graphics Forum (EuroVis'18)*, 37(3):663–686, 2018.
- [10] R. Voeikov, N. Falaleev, and R. Baikulov. TNet: Real-time temporal and spatial video analysis of table tennis. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops*, pages 884–885, 2020.
- [11] L. Wilkinson, D. Wills, D. Rope, A. Norton, and R. Dubbs. *The grammar of graphics*. Springer Science & Business Media, 2006.
- [12] L. Yao, A. Bezerianos, R. Vuillemot, and P. Isenberg. Situated Visualization in Motion for Swimming. In *Journée Visu 2022*, Bordeaux, France, June 2022.
- [13] L. Yao, R. Vuillemot, A. Bezerianos, and P. Isenberg. Designing for Visualization in Motion: Embedding Visualizations in Swimming Videos. *IEEE Transactions on Visualization and Computer Graphics*, 30(3):1821–1836, Mar. 2024. Publisher: Institute of Electrical and Electronics Engineers.
- [14] C. Zhu-Tian, S. Ye, X. Chu, H. Xia, H. Zhang, H. Qu, and Y. Wu. Augmenting Sports Videos with VisCommentator. *IEEE Transactions on Visualization and Computer Graphics*, 28(1):824–834, Jan. 2022. Conference Name: IEEE Transactions on Visualization and Computer Graphics.