Visual Planning and Analysis of Latin Formation Dance Patterns

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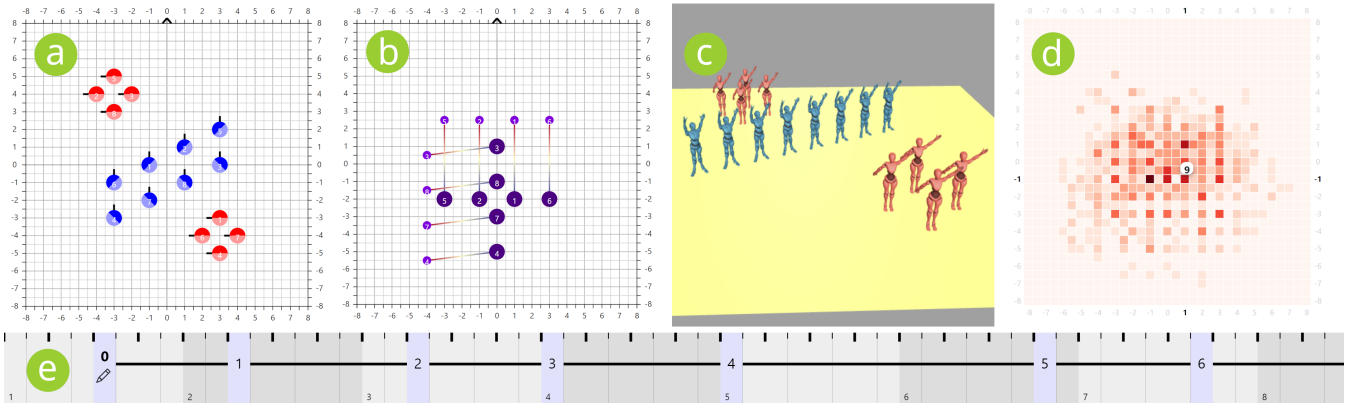

Figure 1: *Included views: (a) the dance floor visualization shows the position and orientation of each dancer in a pattern, (b) the transition view shows the routes dancers take between patterns and reveals potential problems, (c) the 3D view shows dancer poses, (d) the heatmap shows the utilization of the dance floor, and (e) a timeline of the choreography.*

Abstract

Latin formation dancing is a team sport in which up to eight couples perform a coordinated choreography. A central part are the patterns formed by the dancers on the dance floor and the transitions between them. Planning and practicing patterns are some of the most challenging aspects of Latin formation dancing. Interactive visualization approaches can support instructors as well as dancers in tackling these challenges. We present a web-based visualization prototype that assists with the planning, training, and analysis of patterns. Its design was iteratively developed with the involvement of experienced formation instructors. The interface offers views of the dancers' positions and orientations, pattern transitions, poses, and analytical information like dance floor utilization and movement distances. In a first expert study with formation instructors, the prototype was well received.

CCS Concepts

• ***Human-centered computing*** → ***Information visualization; Visualization toolkits;***

1. Introduction

Sports visualization is a growing subfield in visualization [PVS*18]. Most research efforts focus on popular sports like soccer [SJL*18] or ice hockey [PSBS12]. A lesser-known sport that has seen little visualization-related research so far is Latin formation dancing. In Latin formation dancing, up to eight couples perform a coordinated choreography containing five Latin American dances. Compared to couple dancing, the patterns formed by the dancers on the dance floor and the transitions between them are a complementary challenge in addition to striving for synchronicity. Such patterns include lines, diagonals, squares, or diamonds. They make up a large part of the choreographic performance and must be coordinated with the actual dance steps and figures. According to the scoring guidelines of the German Dancing Federation [Ger98], special attention is paid to symmetry, the precision of lines, equality of distances, and equal utilization of the dance floor when scoring patterns. Planning patterns and the transitions between them, communicating them to the dancers during training, and practicing them are some of the main challenges in formation dancing. So far, little use of digital tools has been made for these tasks. Instead, patterns are often still planned on paper, making analysis for potential problems and keeping them

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up to date difficult. As the main reason for this, we attribute the limited functionality of the few existing software solutions.

To mitigate the aforementioned problems, we present a web-based visualization prototype that supports the planning, training, and analysis of formation dance patterns. During the design process, we collaborated closely with three domain experts that combine 24 years of experience as formation instructors. They gave input for requirements at the beginning of the project as well as feedback on a first prototype that enabled us to iterate on the approach. Our prototype includes visualizations of the dancers' positions and orientations in a pattern, pattern transitions, and analytical information like dance floor utilization and movement distances. To the best of our knowledge, it is the first solution to unifying all of these features in one tool. Besides the prototype, we provide a summary of the results of a first expert study evaluating the approach that was conducted using the think aloud method with four formation instructors, three of whom were new to the project. The employed visual encodings and analytical visualizations were well received by the experts. Two of them want to integrate the tool into their choreography planning and training activities.

The visual analysis of athletes' performances via trajectory maps and heat maps is commonly used in sports like soccer and basketball [SJL*18, LTB16]. However, to the best of our knowledge such solutions are not yet widely applied to formation dancing. Also, they are more targeted to spectators instead of athletes while Page and Moere [PM06] claim that visualizations tailored to athletes could prove valuable. Existing tools with a focus on dance choreographies, like ChoreoGraphics from Schulz [SMV13], provide functionalities to capture dance movements, create patterns based on constraints like shapes and the number of dancers, and check transitions for collisions. DanceStudio by Muhammad [Muh09] is another solution that can be used to create patterns for dance choreographies. Users can place dancers on the dance floor to create patterns and automatically compute suited intermediate patterns for transitions. However, there is no differentiation between individual dancers and couples. Furthermore, the visualization is missing basic elements like a grid and axis labels. In general, existing solutions lack the analysis features that we propose with our approach and are usually not web-based, making it difficult to access them during training sessions on mobile devices.

2. Visually Planning and Analyzing Dance Patterns

To support both user groups, instructors and dancers, the tool can be operated in two modes, the editing mode, which allows to interactively create and adjust choreographies, patterns, pattern transitions, dancers' orientations, and poses, and a viewing mode, which allows dancers to explore and internalize the planned patterns. The time-dependent details of the choreography shown in the main view can either be switched through sequentially via corresponding buttons in a toolbar, or controlled directly via the timeline shown in Figure 1e. From the requirement analysis with the instructors results a division into eight beats per bar, which are represented accordingly in the timeline. In the main view itself, different visual representations can be activated through the toolbar to avoid overwhelming instructors and dancers with the simultaneous display of too many details.

The following modes have been implemented: (i) orientation mode, (ii) transition mode, (iii) shape mode, (iv) 3D mode, and (v) analysis mode. The orientation mode, shown in Figure 1a, displays the dancers' head and body orientations represented as glyphs. The glyphs include a black line indicating the head orientation and a two-colored circle indicating the body orientation. The darker semi-circle represents the front and the lighter semi-circle the back of a dancer. The orientations can be adjusted with a set of sliders. Next, in addition to the currently selected pattern the transition mode, illustrated in Figure 1b, also shows the previous one and the paths that the dancers have to take between them. The paths are modeled as piece-wise linear functions and represented by lines colored in a color gradient. The color gradient adds a temporal component to the transition view and enables the visual identification of potential problems in the choreography such as dancers running into each other. If paths do not follow a linear function, waypoints can be added interactively to give a more accurate representation of the real pattern transition. Coordinated with this view is a bar chart that plots the path distance for each dancer. The shape mode allows abstraction from the precise pattern definition by permitting instructors to define shapes computed by the convex hull of a selected set of positions in a pattern. Our intention is to boost the memorability of patterns. Beyond the two-dimensional dance floor visualization we include a three-dimensional visualization showing models of dancers on the dance floor, as illustrated in Figure 1c. The joints of the models can be moved individually to create the poses that dancers assume at the respective position in the choreography. Thus, this mode provides additional information beyond dancers' positions in the pattern. Finally, the analysis mode gives an overview of the whole choreography. A heatmap displays the utilization of the dance floor by indicating for each position how often a dancer stands on it, as shown in Figure 1d. The user can switch between a discrete and a continuous heatmap. Next to the heatmap is a bar chart plotting the movement distance of each dancer over the whole choreography.

3. Expert Study and Future Work

The employed visual encodings, the separation of the main visualization into multiple modes, and the clear user interface were regarded especially positively in our expert study. Furthermore, features like the heatmap visualization for analysis of the whole choreography and the 3D mode for modeling poses add value beyond existing tools. We received valuable feedback on some usability issues that we plan to address in the future like the temporal color encoding of the transitions being hard to understand without additional guidance. Overall, however, instructors and dancers were enthusiastic about the visual approach that was developed. In the future, we plan to follow up with a more extensive evaluation of our approach in a larger case study. Furthermore, we would like to explore solutions using augmented reality and supporting analysis tasks on real performances to provide additional tools that assist instructors and teams in assessing and improving their performance.

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References

[Ger98] GERMAN DANCING FEDERATION (DTV): Wertungsrichtlinien im DTV für formationswettbewerbe standard und latein. https://www.tanzsport.de/files/tanzsport/downloads/sportwelt/formationen/wrichtl-f.pdf, 1998. 1

[LTB16] LOSADA A. G., THERÓN R., BENITO A.: Bkviz: A basketball visual analysis tool. *IEEE Computer Graphics and Applications 36*, 6 (2016), 58–68. doi:10.1109/MCG.2016.124. 2

[Muh09] MUHAMMAD M. N.: Visualizing dance formations: The choreographer's tool, 2009. 2

[PM06] PAGE M., MOERE A.: Towards classifying visualization in team sports. In *International Conference on Computer Graphics, Imaging and Visualisation (CGIV'06)* (2006), pp. 24–29. doi:10.1109/CGIV.2006.85. 2

[PSBS12] PILEGGI H., STOLPER C. D., BOYLE J. M., STASKO J. T.: Snapshot: Visualization to propel ice hockey analytics. *IEEE Transactions on Visualization and Computer Graphics 18*, 12 (2012), 2819–2828. doi:10.1109/TVCG.2012.263. 1

[PVS*18] PERIN C., VUILLEMOT R., STOLPER C. D., STASKO J. T., WOOD J., CARPENDALE S.: State of the art of sports data visualization. In *Computer Graphics Forum* (2018), vol. 37, Wiley Online Library, pp. 663–686. doi:10.1111/cgf.13447. 1

[SJL*18] STEIN M., JANETZKO H., LAMPRECHT A., BREITKREUTZ T., ZIMMERMANN P., GOLDLÜCKE B., SCHRECK T., ANDRIENKO G., GROSSNIKLAUS M., KEIM D. A.: Bring it to the pitch: Combining video and movement data to enhance team sport analysis. *IEEE Transactions on Visualization and Computer Graphics 24*, 1 (2018), 13–22. doi:10.1109/TVCG.2017.2745181. 1, 2

[SMV13] SCHULZ A., MATUSIK W., VELHO L.: Choreographics: An authoring tool for dance shows. *Journal of Graphics Tools 17*, 4 (2013), 159–176. 2