Who kicked the ball? Situated Visualization in On-Site Sports Spectating

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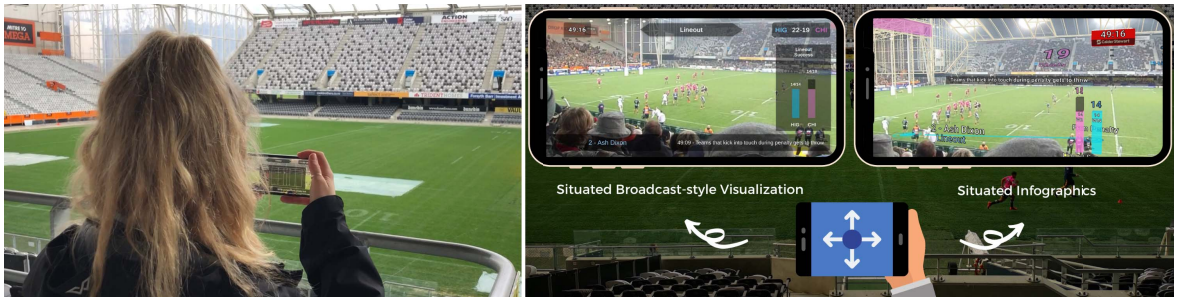

Figure 1: On-site situated visualization for sports spectators. Left) Our prototype used in the real stadium environment. Right) Illustrated user's view of situated broadcast visualization (left) with graphics in screen space and situated infographics visualization (right) with graphical elements embedded spatially into the stadium environment.

Abstract

With the recent technological advancements in sports broadcasting, viewers that follow a sports game through broadcast media or online are presented with an enriched experience that includes additional content such as statistics and graphics that help to follow a game. In contrast, spectators at live sporting events often miss out on this additional content.

In this paper, we explore the opportunities of using situated visualization to enrich on-site sports spectating. We developed two novel situated visualization approaches for on-site sports spectating: (1) situated broadcast-styled visualization which mimics television broadcasts and (2) situated infographics which places visual elements into the environment.

Index Terms: Human-centered computing—Visualization—Visualization techniques—; Human-centered computing—Visualization—Visualization application domains—Visual analytics

1 Introduction

Sports broadcasting has seen major technological advancements in recent years [1,2,6] that allow creating an enriched visual experience for remote spectators by displaying event-related statistics, graphical content, and replays during a sports event. In contrast, on-site spectators have the advantage of the special atmosphere during a live game and being part of a community experience, but often miss out on the additional information available to remote spectators. This lack of commentary and statistics to on-site spectators creates a gap in support in-game understanding, which is vital for the enjoyment of live sports spectating [3].

In this work, we aim to bridge the gap between on-site spectating and remote broadcast experiences by introducing novel situated visualization concepts that are suitable for on-site live sport spectating. We introduce situated visualizations that are related to and presented in the same environment [7]. However, previous research in this area has mostly focused on applications in static environments that are less event-driven than sports games [7, 8]. While there is some research in the area of visual computing techniques for on-site sports spectating, these mostly focus on specific computer vision techniques, for instance, to recognize a player from an input image to output basic player profiles [4].

The contribution of this work is the development of two situated visualization concepts for on-site sports spectating, namely situated broadcast-style visualization and situated infographics. The aim of our work is to analyze the suitability of situated visualization techniques for on-site sports spectating and to develop an on-site mobile situated visualization system where spectators can access statistics and graphical content by pointing their devices towards the field.

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2 System Overview

Our goal is to explore visualization approaches that would benefit sports spectators in the stadium. For this purpose, we developed a flexible infrastructure (ARSpectator) that consists of a mobile Augmented Reality (AR) client and an on-site server providing content (player tracking information and sports databases from commercial sports statistics provider). A mixture of user-guided localization, automatic localization, and tracking (SLAM/Visual Inertial Odometry) were used to initialize and obtain the pose of the mobile client [10].

In addition to the on-site system, we developed multiple prototypes to assist with the development, as there is not always access to a sports event or stadium. These include a lab prototype with a miniature stadium model as well as an indirect AR prototype [9]. The indirect AR prototype features a pre-recorded 360 video of an actual game where situated visualizations are then presented on it and allows us to replicate the live event experience. The prototypes were implemented as mobile phone applications as this is the most accessible option with the opportunity to be ported to an AR head-mounted display (HMD) when the technology is mature enough for long term use.

3 Situated Visualization for On-Site Sports Spectating

We implemented two novel situated visualization concepts for sports spectating, one based on standard TV broadcasting style and a second one in the form of an in-situ AR visualization. This allows us to explore different aspects of familiarity from traditional broadcast and the spatial awareness AR situated visualization can provide.

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3.1 Situated Broadcast-style Visualization

The motivation behind the broadcast-styled visualization option is to mimic the visual layout of traditional sports broadcast on-site. Visualization elements are presented in screen-space, following the layout of commonly seen television broadcasts where the game timer appears on the top left corner, scores on the top left or right corner, and additional details appearing as a banner at the bottom of the screen. The layout is flexible to be customized to sports type specific requirements. The core concept is to visualize data in a two-dimensional format in screen-space. Due to this, most visual elements are presented in the form of text as it is easier to display on screen without distracting the users from the center of the action.

Challenges of this visualization style include the screen size limitation. This creates the risk of information clutter which could impact the user experience [5]. However, due to the similarity to traditional broadcast, spectators are likely to be already familiar with such layout or able to quickly adapt to such a visualization layout as elements remain in place throughout the game. Despite not needing any tracking of spectator poses and players on the field for visual alignment, the game context is still vital for the broadcast-style visualization. Other than knowing when to show visualizations, the context is important for broadcast-style visualization as the system would need to know if it is an appropriate time to display a full-screen visualization. For example, while showing stats during the break, it is possible to fully utilize the whole screen. The same could not be done if the action on the field is still going on, and therefore would require some smart placement of visuals.

3.2 Situated Infographics

The second situated visualization approach we developed is an in-situ AR-style visualization which we call situated infographics. Situated infographics open up the limitations of a restricted screen space as the whole surrounding environment can be the canvas for the visualization. Situated infographics work in a way where data and visual elements are transformed into a 3D visualization and visualized in a 3D space, on-top of their real-world referent, such as a player or location on the playfield. Situated infographics describe a concept of world-centric visualization that takes interconnected entities around the user into consideration and outputs meaningful infographics. This allows situated infographics to be adaptive to events occurring in the environment, such as poll results of other spectators using the system.

Situated infographics not only have the ability to explain and visualize the on-field action but also provide summarized statistics in an easily digestible visual format. The context for situated infographics is important as without spatial context, visualizations would make less sense and any misalignment in the graphics would cause more confusion than assistance. This is particularly important when the referent is dynamic. Hence, context is required for the right timing of visualizations. For an information-rich, envisaged situated infographics product for on-site sports spectating, spectators should be able to choose (automatic and/or interactive) what level of information they want to see. A slight disadvantage of situated infographics would be visualizations on the field are prone to block the actual action on the field, thus would require proper design and considerations to ensure vital components are unaffected by the situated infographics.

4 Conclusion and Future Work

We explored situated visualizations in the context of on-site live sports spectating using rugby games as an example. Two novel visualization concepts were then presented: situated broadcast-style visualization and situated infographics to be used in the stadium. We integrated those concepts into our on-site ARSpectator system to explore the advantages and disadvantages of both visualization methods. Preliminary feedback has shown that both concepts are promising for on-site sports situated visualization as one provides familiarity and the other, spatial context. Either way, the feedback has indicated that having either visualization is better than being on-site without any assistance. That sparked an implementation of a hybrid prototype that combines situated broadcast and situated infographics (Fig. 2) as a starting point for future work. Further studies are however required to evaluate the feasibility of these visualization concepts.

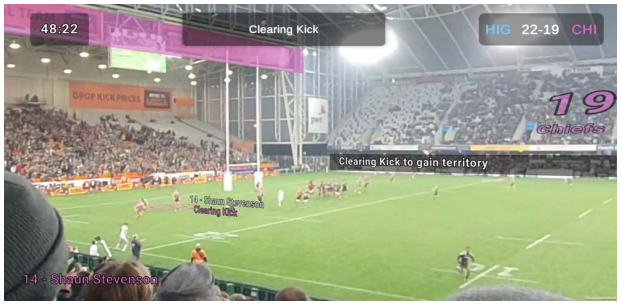

Figure 2: A hybrid prototype which demonstrates a combination of the best of both visualization methods.

Acknowledgments

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