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Augmenting playspaces to enhance the game experience: A tag game case study ☆,☆☆

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ABSTRACT

Introducing technology into games can improve players' game experience. However, it can also reduce the amount of physical activity and social interaction. In this article, we discuss how we enhance the game of tag with technology such that physical and social characteristics of the game are retained. We first present an analysis of the behavior of children playing traditional tag games. Based on these observations, we designed the Interactive Tag Playground (ITP), an interactive installation that uses tracking and floor projections to enhance the game of tag. We evaluate the ITP in one user study with adults and one with children. We compare players' reported experiences when playing both traditional and interactive tag. Players report significantly higher engagement and immersion when playing interactive tag. We also use tracking data collected automatically to quantitatively analyze player behavior in both tag games. Players exhibit similar patterns of physical activity and interactions in both game types. We can therefore conclude that interactive technology can be used to make traditional games more engaging, without losing social and physical character of the game.

1. Introduction

Play has been studied extensively for many years motivated by the positive effect it has on the development of children [1,2]. Besides being fun, play allows children to learn in a playful environment [3], develop and practice norms and beliefs [4], strengthen bonds between friends and family [5,6] or refine motor skills to understand what their bodies are capable of [7]. With the advent of digital games, PC gaming, console gaming and mobile gaming are starting to replace the traditional playground or outdoor gaming that were common a few years ago. Studies have shown that the time children spend consuming media or playing video games is often accompanied by sedentary behavior [8]. This has resulted in a major shift in children's everyday lifes, and the consequences of these changes are slowly coming to light. In most digital games, children can be seen playing "together and apart", playing games with others but not interacting with them [9]. Moreover, digital games have also been linked to the increased amount of sedentary behavior exhibited by young children in western cultures [10]. This shift in play from traditional playgrounds towards living rooms can prevent children from developing the necessary social skills needed later in life, and can be a potential precursor for future health issues.

In an attempt to address these issues, there has been an increased focus on developing games that employ interactive technology. These games are designed to stimulate key aspects of play such as physical activity [11] or social interactions [12]. Other games aim to steer player behavior towards positive outcomes [13,14]. These games can take widely different forms, ranging from small interactive toys [15] to room-sized interactive playgrounds [16]. In many cases, these games are designed to make the body of the players a key component of the interaction, as this has been shown to increase a player's fun and engagement [17]. Although several guidelines on how to design such interactive games or engaging game experiences have been introduced [18–20], special consideration needs to be given to how introducing interactive technology can affect the physical and social aspects of play [12].

One way in which this can be accomplished is proposed by Tetteroo et al. in [21]. They created a design taxonomy that contains key elements of play derived from traditional children's outdoor

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game analyses and literature. With this, they propose a method to design interactive playground games. We, on the other hand, propose to augment an existing traditional playground game that already promotes social and physically active behavior through play. By enhancing the play environment in which the original game is played, we aim to improve the game experience by making it more fun and engaging without getting in the way of how the game would traditionally be played. Our approach is to analyze how the game is played, and design an interactive installation that supports the play style exhibited by the players.

In this study, we enhance the traditional playground game of tag. In tag, children adopt one of two roles: tagger or runner. When players are taggers, their goal is to chase runners and tag (touch) them. When they are runners, their goal is to avoid being tagged by the taggers. If a player is tagged, the roles of both players switch. These simple rules allow new players to understand the game quickly and join others almost immediately. However, prolonged play can lead to boredom since there are no win conditions. By introducing technology into the playground, we envision a plethora of opportunities to enhance the game which would otherwise not be feasible.

In this paper, we first describe a pilot study where children were asked to play tag in an uninstrumented open space. The game sessions consisted of different versions of tag games, played with a varying number of players. These game sessions were recorded and analyzed to derive characteristics of how the game is played [22]. Based on these findings, we designed and implemented the Interactive Tag Playground (ITP), an interactive game installation that aims to enhance the game experience of traditional tag games while allowing players to exhibit playful, physically active and social behavior [14,23]. The ITP tracks players inside the playground, display game elements on the floor, and guide interactions by processing the game logic. By doing this, the ITP becomes *de facto* a referee, enforcing rules for the players in situations where disagreements arise. Additionally, the ITP facilitates the analysis of player behavior by logging automatically collected player data such as position and role. By using this information in-game, researchers can explore different gameplay interactions and elements and quickly see how they affect player behavior. By using it offline, researchers can carry out player behavior analyses without the need of annotation, significantly reducing the time involved in the process.

To evaluate our playground, we conducted two user studies in the ITP where we asked participants to play both traditional tag and interactive tag. The first study was conducted with adults, the second study with children. In both studies, we evaluated three aspects of the ITP. First, we evaluated whether the ITP enhances the game experience of traditional tag games. Second, we checked whether the augmented tag game allows players to demonstrate physically active and social behavior. Third, we analyzed specific behavioral cues important in tag games to showcase the potential of the ITP as a game research platform. We accomplished this using questionnaires, semi-structured interviews, observations, and objective analysis of the data automatically collected by the ITP.

This article is structured as follows. In the following section, we present a short overview of how technology is used to enhance games, and point out design considerations. In Section 3, we describe our study of traditional tag games, highlighting the requirements needed to build an installation that supports this style of play. In Section 4, we introduce our interactive installation, the Interactive Tag Playground. In Section 5, we describe our two user studies, the results of our observations and the discussions with the players. We also present the results of the game experience evaluation and the player behavior analysis of the interactive tag games. Finally, we summarize our findings and discuss avenues for future work in Section 6.

2. Enhancing games using technology

Besides creating novel games, technology can also be used to enhance the user experience of traditional games. For instance, the "BuzzTag" installation provides players the opportunity to play games similar to traditional tag games, but using interactive devices to enhance the interaction [24]. One of the main goals is to maintain face-to-face social interactions during play. To this end, they use wireless devices that provide haptic, visual and auditory feedback. In "BuzzTag", the player who possesses the "buzz" needs to get rid of it by tagging other players. Another example is the "Table Tennis for Three" game installation designed by Mueller et al. [25]. The goal of their installation is to allow players that are not physically colocated to play table tennis together. Furthermore, instead of just playing against one other player, you play against two.

Technology can also be used to enhance games by modifying gameplay elements based on automatically measured player data. For example, heart rate measurements have been used to change game elements in the "Beats Down" mobile game [26]. Their game concept resembles the well known "whack-a-mole" game: given a set of tiles, the user needs to quickly tap the tiles that are flashing. There are two variations of the game. In challenge mode, heart rate is used to modulate the flashing frequency, allowing players to get more points by increasing their heart rate and, therefore, the number of flashing tiles. In relax mode, players get point multipliers that increase as the player's heart rate decreases. Navarro et al. also use heart rate measurements to adapt actions in-game in the "Webz of Wars" game [27]. Right before the game starts, a baseline heart rate measurement is taken. Afterwards, in-game heart rate measurements are used to scale the power of a player's attacks. The higher the heart rate is in comparison to the baseline, the more effort the player is putting in, the more powerful the attack gets. Landry and Pares also look at player exertion, but propose computer vision algorithms to measure it in the "Interactive Slide" [28]. The installation consists of an inflatable slide equipped with a camera projection system, in which the cameras are used to track players and the projectors are used to display the game elements onto the slide. By measuring the amount of movement of groups of players, the system is able to adjust the tempo of the game, triggering different amounts of physical activity.

One specific type of gameplay adaptation that has been used in many studies is skill balancing. Skill balancing aims to help people with different skills play together by changing game elements. The adaptation can be achieved by automating processes based on in-game measurements, or offline based on previous player information. The latter, for instance, was used by Altimira et al. when attempting to balance player' skills in Wii table tennis [29]. Players were asked beforehand to assess their own skill at table tennis, and the best players were given handicaps before the game sessions. To balance skills using automated measurements, data can be obtained from external sensors or from the game itself. Stach et al. balance the difficulty of a cycling exergame using heart rate monitors [30]. The "Heart Burn" racing game allows people of different fitness levels to compete not by measuring the speed at which they cycle, but the effort they put in as measured by their heart rate. This information is used to scale their in-game performance. On the other hand, Vicencio-Moreira et al. use in-game data to balance the skills of opposing players in a first-person shooter [31]. They use two methods to achieve this: "Bullet Magnetism", which makes bullets home in on the target within a given activation range, and "Area Cursor", which increases the activation area for a target hit. The assistance is given to the player with the least number of kills, in proportion to how far behind from the other players he is.