Sonic Tennis: a rhythmic interaction game for mobile devices

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ABSTRACT

This paper presents an audio-based tennis simulation game for mobile devices, which uses motion input and non-verbal audio feedback as exclusive means of interaction. Players have to listen carefully to the provided auditory clues, like racquet hits and ball bounces, rhythmically synchronizing their movements in order to keep the ball into play. The device can be swung freely and act as a full-fledged motion-based controller, as the game does not rely at all on visual feedback and the device display can thus be ignored. The game aims to be entertaining but also effective for educational purposes, such as ear training or improvement of the sense of timing, and enjoyable both by visually-impaired and sighted users.

Keywords

Audio game, mobile devices, sonic interaction design, rhythmic interaction, motion-based

1. INTRODUCTION

The vast majority of computer games being developed nowadays heavily relies on visual elements shown on a screen. Even when present, other kinds of information such as audio or haptic feedback are mostly added just for aesthetic purposes and not actually useful in the gameplay. Audio-based games are a relatively small nieche which tries to subvert this paradigm, exploiting the auditory channel instead of the visual one to convey all the in-game context. They are therefore accessible to visual-impaired users [1, 13] and have great potential in terms of ear training and enhancement of one's listening capabilities [12, 3].

Audio-based games are also particularly well suited for mobile devices or other embedded applications, where the available processing power is sometimes very limited and the display is usually very small, if it is present at all [10, 9]. Perhaps one of the most interesting examples is represented by the DigiWall [5], a gaming platform made of a climbing wall augmented with a high fidelity sound system and luminous handles. The change of focus from sight to hearing becomes even more disruptive on those devices equipped with touch-sensitive displays, as usually all the interaction with the device happens not only *with* the screen but also physically *on* the screen.

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Features commonly found in most modern smartphones, such as GPS positioning systems and digital compasses, allow the design of games based on auditory augmented reality enviroments [6], which may use verbal information to describe visual situations [8, 2] or rely on completely non-verbal soundscapes [7].

In this paper we propose an audio only game that exploits another feature commonly found in modern smartphones, namely the presence of motion sensors such as accelerometers and gyroscopes. As the user is not required to keep the eyes on the screen, the device can be held and moved in many different ways, becoming a full-fledged motion-based controller. The user can thus interact with the game using physical gestures, taking advantage of the auditory feedback and proprioception.

2. DESIGN AND IMPLEMENTATION

We implemented an audio-based game inspired by the sport of tennis. In this game, players take advantage of rhythmic interaction [4] and auditory feedback in order to strike a hit. The game is controlled by performing three different physical gestures, detected using the data coming from both the accelerometer and the gyroscope embedded on an iPhone: a *forehand* hit, a *backhand* hit and an overhead *smash*.

The user receives three different sound signals as feedback: the sound of one's own racket hitting the ball, the sound of the hit coming from the opponent's racket and the bounces of the ball on the ground. The goal of the game is to perform the correct gesture at the right time, in order to hit the ball. The player which first misses three balls loses the game. In order to inform the users of how and when they should hit the ball, the sonic feedback is currently modulated by three parameters:

- **Rhythm interaction:** In the game instructions a sample sound sequence can be heard, representing the action of the players hitting the ball and the bouncing of the ball on the floor. Players have to perform their actions in order to rhythmically replicate the given sequence as precisely as possible. Good synchronization triggers an increase in tempo, making the ball go faster and therefore increasing the difficulty for the opponent. Similarly, bad synchronization results in a decrease in tempo, making the ball go slower and therefore decreasing the difficulty for the opponent.

- **Sound spatialization:** Simple stereo panning of the sounds triggered by the opponent is used to determine the direction of the hit: if the hit comes from the left the player must strike back from the left side of his or her body, if the hit comes from the right the player must perform a strike from the right side of his or her

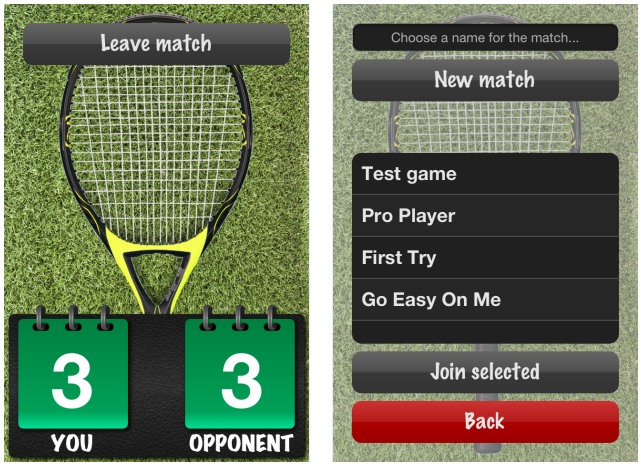

Figure 1: The Graphical User Interface of the game. Right side: the GUI, left side: the settings view.

body. The gravity vector coming from the accelerometer is used to infer the direction of the strike.

The game client is an app developed in Objective-C for iOS 4.3 or later, and communicates with a custom server developed in Python via text-based TCP messages. The client presents a minimal Graphical User Interface (GUI) (see Figure 1) consisting of two views: the main view is merely an image of a tennis racket occupying the whole screen and a scoreboard. The settings view contains controls to start or join a match. All in-game information is given uniquely by sound.

The implementation presented in this paper features audio signals which recall the actual sound of a tennis ball. To enhance realism, the hits performed by the player and the bounces happening on the player's side of the court appear louder and closer than their counterparts happening in the opponent's side of the court. These choices are based on ecological considerations of how sound amplitude is perceived in the real world.

3. FUTURE DEVELOPMENTS AND CONCLUSIONS

In this paper we presented a prototype of a rhythmic sonic tennis game, which shows a great potential for educational purposes such as ear training or enhancement of listening abilities. As a matter of fact, the sound parameters used to modulate the audio signals are strongly related, if not directly mappable, to musical features and concepts.

Though not yet implemented, further development envisages that at random time the bounce of the ball on the ground might sound different. At that moment, the player is given either the opportunity to perform a very powerful overhead smash or the challenge to quickly recover from a sneaky bounce on the net, forcing both opponents to keep a high level of attention on the game and to respond precisely. We are also implementing continuous sonic feedback in future iterations of the game, in such a way that the player can constantly monitor the virtual position of the ball by listening to the sound cues produced. We are also considering adding non-realistic auditory feedback in the game. For example, drumkit or percussive samples could be used to highlight the rhythmic structures, while tuned sounds would allow players to generate melodies while playing the game.

Even if an extensive evaluation has not yet been performed in that sense, preliminary tests and results look very promising and certainly deserve further exploration.

The design of other game modes, including a single player practice mode and a four-player simulation of a double match, is currently a work in progress. Additionally a "massively multiplayer" version of the game, playable by hundreds of users simultaneously, is currently being designed for a participatory electronic music performance. The audience, divided in teams, will be requested to play in sync with the performers on stage, with their movements influencing and modifying in real time the music played for the concert. The mobile device thus opens possibilities of interaction with music, with the performers and with the social environment of the venue, promoting democratization and participation in the process of making music as envisioned in [11]. The two players version of the game is the one that will be demonstrated at the conference.

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