Table Tennis for Three – The Video

Florian 'Floyd' Mueller

The Department of Information Systems

The University of Melbourne

Parkville, VIC 3010

Australia

floyd@exertioninterfaces.com

Martin Gibbs

The Department of Information Systems

The University of Melbourne

Parkville, VIC 3010

Australia

martinrg@unimelb.edu.au

Figure 1. Table Tennis for Three.

Abstract

Physical leisure activities such as table tennis provide healthy exercise and can offer a means to connect with others socially; however, players have to be in the same physical location to play. We have developed a networked table tennis-like game that is played with a real paddle and ball, augmented with a large-scale videoconference. Similar to networked computer games, this concept can support more than two locations. We are presenting a video of our latest prototype "Table Tennis for Three". Table Tennis for Three has potential to achieve similar benefits known from traditional physical leisure activity such as

exercise, enjoyment and bringing people together to socialize.

Keywords
Table-tennis, ping pong, Exertion Interface, physical, tangible, videoconferencing, sports, active, exhausting, sweat, team spirit, social interaction

ACM Classification Keywords
H5.2. Information Interfaces and presentation (e.g., HCI): User Interfaces.

Leisure Activities
Leisure activities, such as table tennis, are an important part of people's lives. The benefits of leisure activities on personal well-being have been widely discussed: from a mental health perspective, leisure is believed to have a beneficial effect on psychological well-being by promoting positive moods and it can help overcome loneliness [12]. From a physical health perspective, athletic leisure activities contribute to a healthier body, reducing the risk of obesity, cardiovascular disease, diabetes, and more [13][14]. Table tennis is an example of a popular leisure activity, played worldwide by players of all ages and capabilities. Table tennis helps to develop hand-eye coordination, agility and reflexes and can contribute to general fitness [19] [9]. Due to its relatively low entry barrier, it can also serve as an ice-breaker for social interactions. In fact, research has shown that many of the benefits of leisure are the result of its capability of fostering companionships and friendships [12]. However, the players have to be in the same physical location to play a game.

Networked Games
One way of allowing family and friends in geographically distant locations to enjoy leisure activities together is through networked computer games. These games offer players a shared experience, but often fall short in providing a personal, casual interaction, supporting various age groups, characteristic to collocated leisure activities. Computer games with their gamepad interaction are often criticized for their support of a sedentary lifestyle and social isolation of their players. In contrast, traditional leisure games support physical and athletic interactions such as jumping, kicking, throwing and running.

Exerting Distributed Leisure
To provide an opportunity to maintain connections with long-distant friends and relatives, we have incorporated physical interactions similar to a table tennis game with telecommunication technology to create a new experience that allows participants to enjoy an exerting leisure activity together although geographically apart.

Breakout for Two [5] has demonstrated that a physical leisure activity (kicking a soccer ball) can be enjoyed by two geographically distant participants. Evaluation showed that the exerting activity is superior in promoting a social bond between the players to a similar mouse-keyboard interaction. With our current work, we are aiming to show that the concept combines the advantages of networked computer games (supporting multiple geographically distant players) with the advantages of traditional exerting leisure games (health and social benefits). The video demonstrates that this concept scales to three locations easily.

Table Tennis for Three

We have designed a networked game that is based on table tennis, but can be played by players in three geographically distant locations. Although it has different rules than table tennis, the use of a table tennis table and a paddle and ball inspired us to name it *Table Tennis for Three.* Through the inclusion of a videoconference, the game aims to support social interactions between the players. The gameplay is based on successful elements of *Breakout for Two*, with a focus on the *Exertion Interface* [5], and an extension to three locations. Just like table tennis, it is easy to learn and supports a sense of achievement quickly. *Table Tennis for Three* provides a health benefit by encouraging physical activity and training reflexes as well as hand-eye coordination. However, *Table Tennis for Three* is not aimed to replace traditional table tennis, but rather be the next best alternative if the participants cannot be in the same location together.

Gameplay

Each player has a table tennis table, a paddle and a ball. The table is set up so that the ball can be hit against the vertically positioned opposite half of the table [Figure 1]. This setup is familiar to table tennis players who practice on their own by playing the ball against the board. The vertical part of the table is painted white to also serve as a projection surface for a videoconference of the other two players. Projected over the videoconference are eight semi-transparent targets that players have to hit with their ball. These targets, or blocks, "break" when hit by the players. The blocks are synchronized across the three tables, so the other players see the same block layout and the same block states [Figure 2]. If a block is hit once, it cracks a little. If it is hit again (regardless by which player), it

cracks more. If hit three times, it breaks and disappears, revealing the underlying videoconferencing completely: the player broke through to the remote players. However, only the player who hits the block the third and final time makes it disappear and receives the point. This adds an element of strategy to the game: a player can try to snatch away points by hitting blocks that have already been hit twice by the other player. Each broken block scores one point, and once all blocks are cleared, the player with the most points wins the game.

The Video

The video of *Table Tennis for Three* (http://www.exertioninterfaces.com/table_tennis_for_three) shows our prototype in action: several players were recorded who played with friends and people they have not met before. They hit the ball with their paddles, chase balls they missed, and interact with one another through the videoconference. The three locations were in the same building, but in separate rooms; however, a sport court might have been preferable to the lab environment. The sound output from the remote sites was routed through speakers so that the video camera could also record the audio transmitted. This led to some echo effects that could have been avoided by using the Bluetooth earpiece as output instead of the speakers.

The players laughed and joked during the game, and especially after each round, which lasted for around 1-2 minutes, complimented or criticized each other for winning or losing. Although players who have known each other beforehand tended to converse more, others who have never met before showed more social interaction than groups that have been friends for
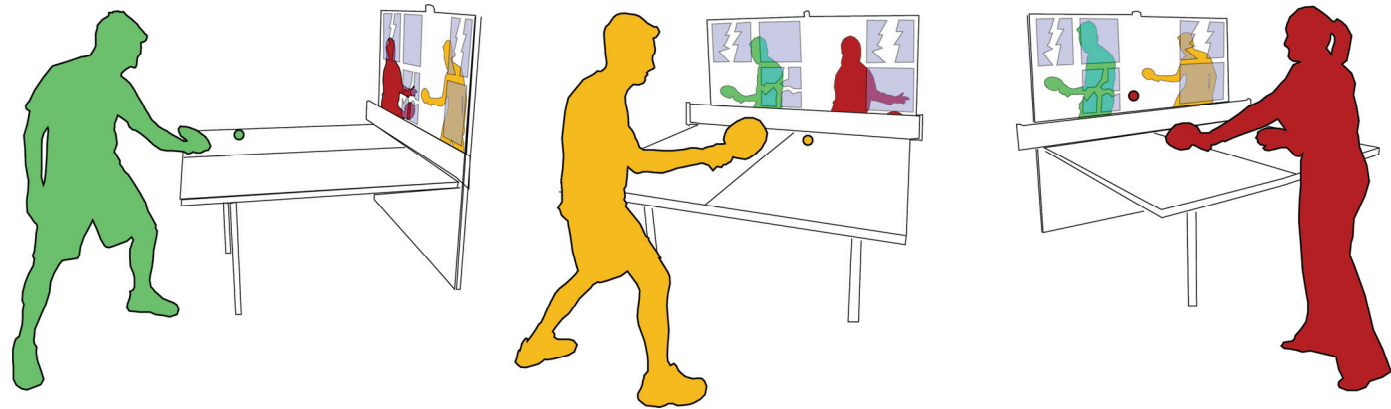
Figure 2. Each player sees a videostream of the other two. Overlaid are the blocks in their various broken stages. The blocks are synchronized, so they look identical for all players.

years. Competition appeared to be an important part of the game, with players discussing what the best strategy for winning was, and how to modify the game to allow for different skill levels. The winning player often cheered out loud or did a winning dance to celebrate their achievement!

Target Audience

Table Tennis for Three targets active people who want to stay in touch with family or friends who are living far away. The system provides a casual gaming experience with a sports character that is appealing to young and old, similar to table tennis. It can provide a reason to interact and can also serve as an ice-breaker between strangers. Just like table tennis, it is easy to learn, does not require a large court, and supports a sense of achievement quickly. We believe anyone who can play table tennis can play *Table Tennis for Three*. The system can also provide a health benefit by

encouraging physical activity and training reflexes as well as hand-eye coordination.

Technical Implementation

Currently, the game has been implemented in three different rooms of one building, connected via a LAN. Most bandwidth is consumed by the videoconferencing system, but the software is designed to accommodate for various bandwidth settings, so a deployment via the Internet is feasible. The videoconferencing software is implemented independently from the overlaid gameplay, and can therefore easily be updated if better codecs become available. The backs of the tables are instrumented so that the time and approximate location of a ball striking the table can be detected [Figure 3]. Eight piezoelectric sensors are attached to the rear of the backboard in locations corresponding to the gameplay blocks projected on the front of the
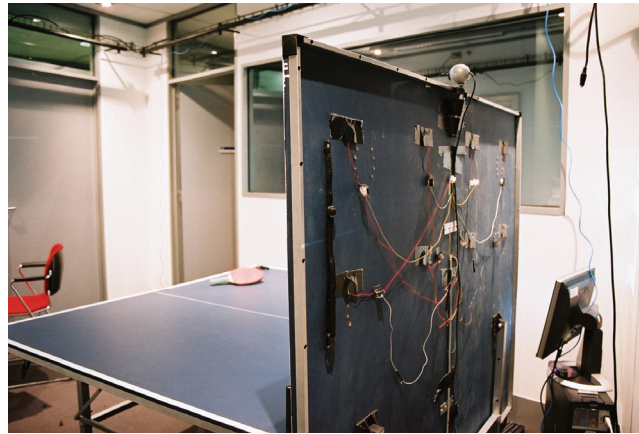
Figure 3. View from the back with the sensors.

backboard. The sensors detect the sound vibrations in the wooden board created by the ball striking it. The one sensor that receives the vibration signal first determines the location of the impact. A camera is placed in the centre of the upper edge of each backboard. This camera is used to capture and send a video conferencing stream to the other table.

Preliminary Evaluation

Table Tennis for Three was developed to create a sense of social rapport between three people simultaneously, although they are geographically apart. We were therefore interested in feedback from players and hence undertook an evaluation. We were particularly interested in whether the system supports social interaction. Furthermore, we were keen to find out if the system is fun and enjoyable for the players and considered a leisure activity.

We recruited 41 participants (one participant played twice, his second round was excluded from the

analysis) who played between 20 and 30 minutes. The game was followed by a questionnaire the players were asked to answer on a typical Likert scale, ranging from "strongly agree" to "strongly disagree". The participants were between 21 and 55 years old (arithmetic mean 31.63 years), whereas 27 were male and 14 female. Following the questionnaire, the players were asked to take a seat on a couch, where they were interviewed together. The interview lasted about 20 minutes for all groups; it was semi-structured and videotaped.

The evaluation of the system showed that the players had fun, they reported it created a sense of connectedness, and they were excited about being able to play "together", which gave them "something to talk about", although being in different locations. The affordance of the table tennis game allowed participants to quickly engage and interact, and most players (more than 70% for each question) reported that they enjoyed the game, considered it a workout, forgot the world around them when playing, and wanted to play again. However, at least two participants reported on a negative experience and one called it "annoying". Both players mentioned they had trouble understanding the other players over the limited VoIP audio channel, which was probably one factor that affected their experience. Further analysis should shed light on this, and ultimately might result in design recommendations for future physical games that span multiple locations.

Related Work

An example of a networked physical activity experience is *Haptic Arm Wrestling* [10], which is installed in museums across the USA. The device includes a videoconference to arm-wrestle other visitors over the

distance. The *Virtual Fitness Center* [4] is a research project that uses networked exercise bicycles to motivate distributed cyclists; Fitcentric [16] offers a similar commercial product, but without video or audio support. The *Wii* game console comes with a controller that contains accelerometers to support physical activities in its games; however, it does not support the inclusion of a videoconference as yet [17]. *PingPongPlus* [2] utilizes a table tennis table: a projection is augmented on the table that reacts to the impact of the ball; however, it supports only two collocated players. Three players can play ping pong with *TriPong* [18], but they need to be around the same table.

Airhockey over a Distance [6] is a leisure game that is playable by players in different locations: it uses a physical puck that is shot out at the remote end by puck cannons. *Push'N'Pull* [7] is a networked exercise machine, which the players use as interface for a cooperative game, supported by a high-definition videoconference. *Virtual Tug-of-War* [8] is a physical group activity in which two teams were involved in a tug-of-war 13 miles apart from each other. These examples support a communication channel between the participants; however, they are limited to two locations.

Several researchers have built virtual reality [3] and augmented reality versions [1] [11] of table tennis. However, they either lack force feedback of the ball hitting the paddle, or are not playable by distributed participants. Our approach does not require the players to wear any technology, because we believe wearing devices such as head-mounted displays might negatively affect the social interaction between the players. We wanted to support a simple "show up, grab a paddle, and play" approach, which we believe is conducive to social interaction and enjoyment.

Future Work
An investigation of the social effects on a two player version could lead to some interesting comparisons. We are also working on installing the system permanently in museums to observe the interactions between strangers who have to challenge one another in order to be able to play.

Conclusion
Table Tennis for Three aims to combine the advantages of networked computer games (supporting multiple geographically distant players) with the advantages of traditional exerting leisure games (providing a social and health benefit). We present a video that demonstrates that this concept can scale to three players in three locations. Ongoing evaluation work indicates that the system can aid players in creating a sense of social rapport. This adds support to the claim that physical activity can be beneficial to social interaction. We hope to inspire researchers of other augmented leisure games to offer support beyond two locations and encourage designers of future distributed physical games to support social interactions.

Acknowledgements

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