E-Ball: A Hybrid Athletics/Video Game

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ABSTRACT
In traditional computer games, the players are generally facing the screens, and using mice, keyboards or joysticks as the game controllers. Human senses and the natural interactions of players are lost. E-Ball is a hybrid Athletics/Video game based on the concept of computer supported collaborative play (CSCP). It collaborates the natural and enjoyable recreational interaction between players with the exciting elements of computer games. Natural physical world interactions and social aspects of traditional game play are regained. This system doesn't need expensive components and the implementation is simple. The easy-to-learn, full-body motion, speed and rhythm of this game make the interaction very engaging and entertaining.

Keywords
Interaction, CSCP, Computer Games, Social Computing, Hybrid Athletics/Video Game

1 INTRODUCTION

Pleasure, enjoyment and fun are fundamental to life [1]. Games and sports are important sources of fun and enjoyment. Since the invention of computers, computer games have been an exciting component of computer science and computer applications.

Now days, computer games are played by millions of peoples. But most of the games are played along. Even in the online network multiplayer games, the players are generally facing the screens, and using mice, keyboards or joysticks as the game controllers. Human senses and the natural movements of players are not utilized in a versatile way in these interfaces. And the players' attention mainly focuses on computer screens or 2D/3D virtual environments, rather than interactions between humans. Players have very little physical body movement, and a much smaller physical area of game space comparing with when they play a conventional type game. Thus, the 2D screen becomes an abstractive and indirect obstacle between the player and the game context. Physical and social interaction is constrained, and natural interactions such as gestures, body language and movement, gaze, and physical awareness are lost. [6]

In conventional sports and games, they are designed and played out in the physical world that we live in. In order to make use of real world properties, such as physical objects, our sense of space, and spatial relations, games are also often played by groups of people, to make use of our social interaction abilities. Players move naturally and work together during the game play. Social interaction and communication are parts of the games.

Generally speaking, Humans are fundamentally social creatures. From birth we orient to other people, and as we develop we acquire abilities for interacting with one another ranging from expression and gesture through spoken and written language. As adults, we are exquisitely sensitive to the actions and interactions of those around us. Every day we make countless decisions that are shaped by our social context. Social information provides a basis for inferences, planning, and coordinating activity. When we move from face to face interaction to digitally-mediated interaction, however, everything changes. The subtle social cues that we use to guide and structure our real world interactions are mostly absent. In the digital world we are socially blind, and our attempts to communicate can be awkward and labor-intensive. [8] Social Computing focuses on the study of these issues. The concept of Social Computing proposes that the real-time and real-space activities of humans as social beings are placed at primary importance in the process of human and computer interaction. [7] Based on this concept, we construct a novel game space that collaborates the natural and enjoyable recreational interaction between players with the exciting

elements of computer games, as well as simultaneously offering natural physical world interactions and regaining the physical and social aspects of traditional game play.

A lot of research has been done in this area. Sidney [2] developed a new music controller Tooka, which is played by two players. The players have to anticipate and predict each other's responses to play Tooka. As the ability to predict each other's responses grows, intimacy builds. This intimacy allows people to have close, meaningful and expressive bonds. Hanna Stromberg [3] designed a group game Nautilus played in an interactive virtual space. The players use their natural body movements and interactive with each other to control the game. Ishii et al. [4] defines computer supported collaborative play (CSCP) as "computer technology that enhances physical exertion, social interaction, and entertainment in sport and play." Their PingPongPlus game is an example of an athletic tangible interface for collocated, competitive play. Regan L. Mandryk developed a Hybrid Board/Video Game, which leverages the advantages of both physical and digital media and has the potential to enhance natural and enjoyable recreational interaction between friends. Adrian David Cheok [8] designed a game called Touch-Space based on Mixed Reality (MR). Two players with HMDs cooperate physically with each other to fulfill an adventure task. Toshikazu Ohshima's AR^2 Hockey [9] is a collaborative augmented reality (AR) system for real time, interactive operations. In this system the players can share a physical game field, mallets, and a virtual puck to play an air-hockey game. In all these researches, the social interaction between players is the main idea of the designing. Although computers mediate these games, the human-human interactions define the game play and eventual outcome.

However, the above research projects emphasized different aspects of Social Computing and CSCP. Toota is mainly dealing with human cooperation in digital instrument playing. Nautilus, Hybrid Board/Video Game and Touch-Space are not athletics games, and needs complicated implementation. The PingPongPlus demonstrated an instance of an athletic-tangible interface, but it seems to focus on esthetic aspect of the game, and also needs the players have the skills of playing PingPong. AR^2 Hockey is a complicated system, and the players also have to wear HMDs. The play process is not as natural as the traditional game.

In our E-Ball system, we hope to build a real athletics game. In the game, some special equipment, such as HMDs are not needed. The players can be cooperative or competitive. It is supposed to be easy-to-learn, full-body motion, and with speed and rhythm to make the interaction more engaging and entertaining.

2 DESIGN

Using a user-centered design approach, we analyzed the characteristics of both categories of traditional and computer tennis, ping-pang and hockey games. The Following set of requirements was identified:

1. The semantics of the physical interaction shall be maintained as much as possible.
2. The exciting features of computer games shall be remained as much as possible.
3. The number of players shall be changeable. For example, it may be from 1 to 4.
4. The relationship between the players shall be flexible. The players might be cooperative or competitive. They even can play with the computer opponent.
5. The system shall be simple and easy to set up.
6. It shall be suit for a broad range of people.
7. The game roles shall be simple. It shall be very easy to learn and not need special skills.
8. The computer shall be hidden. The players shall focus on the game rather than on communicating with the computer.

3 SYSTEM ARCHITECTURE

Figure 1 is the system block diagram. Figure 2 is the photo of the E-Ball system.

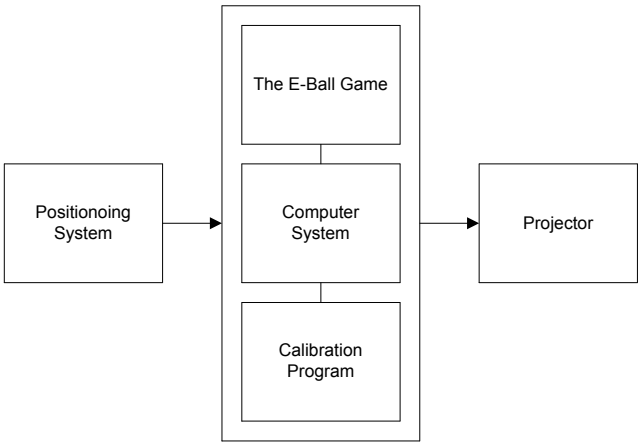

Figure 1: The block diagram of the E-Ball game.

Projector

We use a standard Panasonic PTLC-50U LCD projector to cast the computer display on the wall (table or floor).

Computer System

A Dell Latitude 610 Laptop (PIII 700) is used as the controller computer. The operating system is Windows XP Professional.

Positioning System

The positioning system module is used to trace the positions of the players' rackets (or sticks). We were planning to use the LPS (Local Positioning System). Because it was not available, we use a USB Web Cam to trace the positions. We put red and blue markers on the rackets. The Web Cam captures the scene at a rate of 15 frames/second and each frame is processed by the system. The red and blue signs are isolated and the positions are obtained. This module is coded with VC++6.0.

Calibration Program

The images captured by the Web Cam are distorted. So Calibration is needed to obtain the correct position information. We have two calibration options. One is Precise Calibration Method using the Camera Calibration Toolbox for Matlab® [10]. In the stage of setup, the projection matrix can be obtained by this method. Then each position value is calibrated by it. This method is complicated and needs long time to set up the system.

Another one is Simple Calibration Method. We put the Web Cam close to the projector and obtain the images at a similar angle. We just map the position of the projector display area in the images with the computer screen display. Several parameters can be adjusted interactively to obtain a correct calibration result. This method is simple and very easy to conduct. Figure 3 is the picture of the rackets with red and blue markers.

In our test we use the Simple Calibration Method. The results are fine.

E-Ball Game

There are many computer games using the strategies of play a ball (or balls) with mouse (or keyboard) controlled paddles. In our test system, we just create a simple bouncing ball program. The paddle images are hidden. The players use physical rackets (or sticks) to hit the ball. The basic rule is that the players should try to hit the ball and don't let the ball touch the goals (boundaries) of their sides. Each time a player fails to prevent the ball hitting the goal of his/her side, the opposite player gain a point. The player whose score reaches the determined value wins the game. Figure 4 is the screen shot of the E-Ball Game.

4 OPERATION SCENARIO

The E-Ball game can be implemented with three different scenarios.

Figure 2: The E-Ball system.

Figure 3: The racket with red and blue markers.

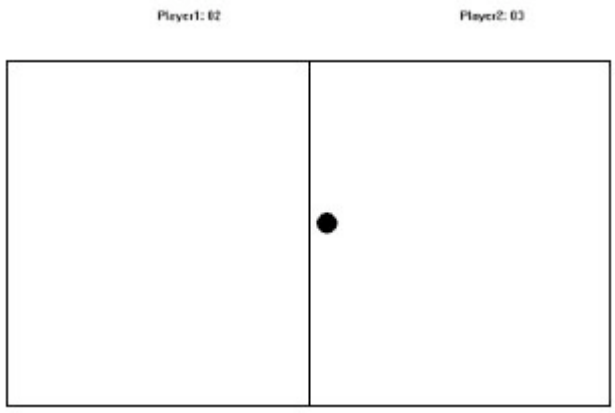

Figure 4: The E-Ball game.

E-Hockey
The display is projected on the floor. The players can use hockey sticks to play the game. The ball acts as a virtual puck. The positioning markers are tagged at the ends of the sticks.

The scenario allows many (such as 4) people play the game together. The players can be competitive or cooperative. They also can play with the computer opponent.

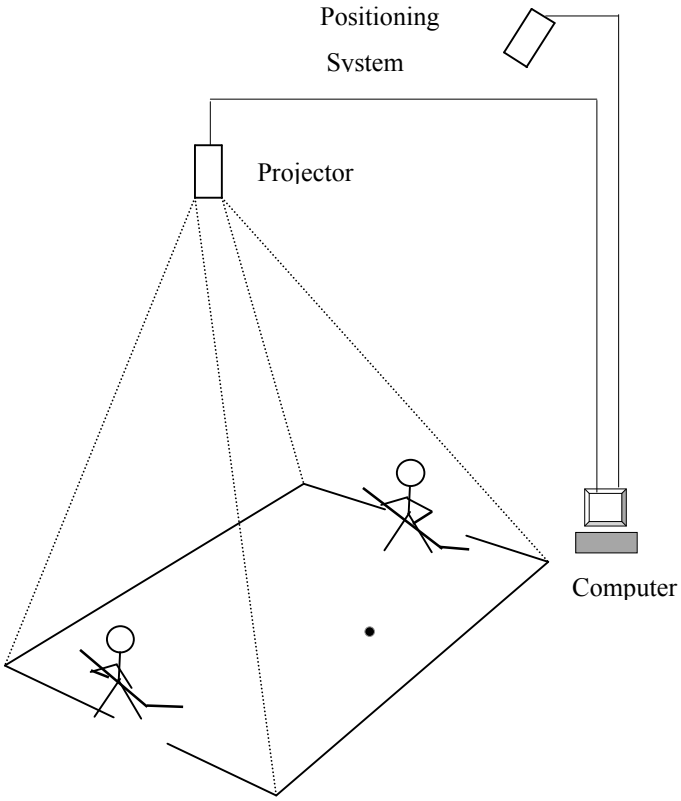

Figure 5. E-Hockey Scenario

E-Ping Pong
In this case, the display is projected onto a table surface. The game play is similar to a Ping Pong game.

E-Tennis
The display also can be projected on to a wall surface. In this situation, this game is played as tennis.

Because of the limitation of the environment, we only implemented this scenario.

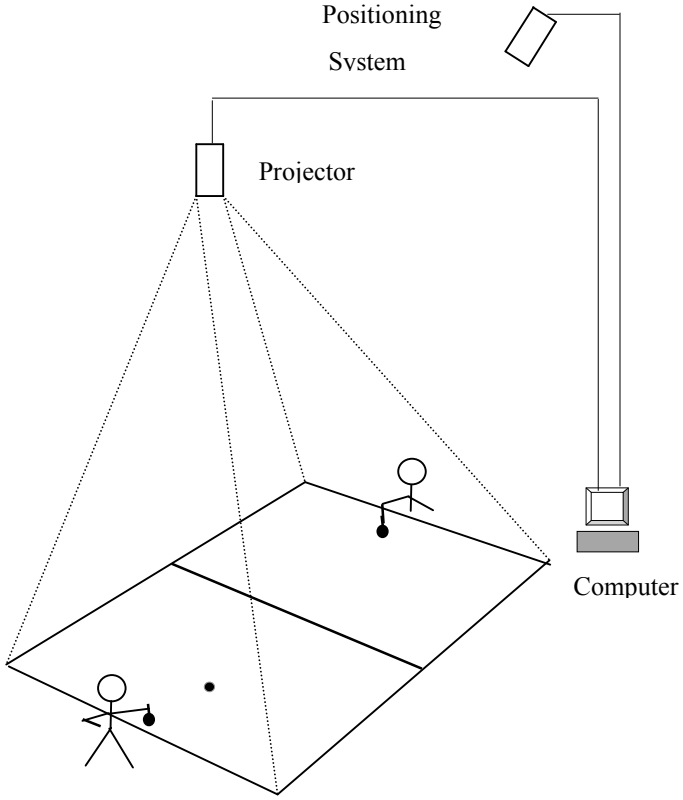

Figure 6. E-Ping Pong Scenario

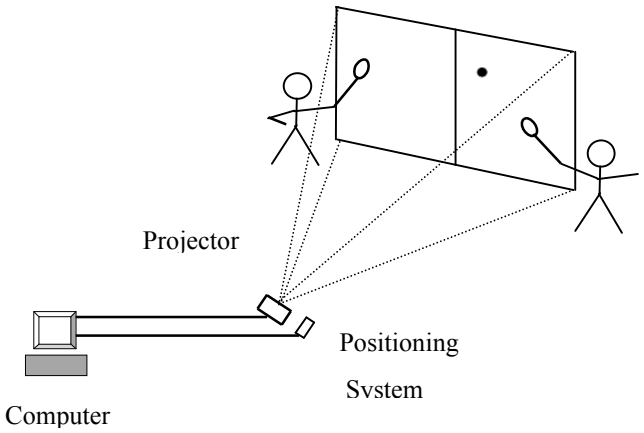

Figure 7. E-Tennis Scenario

5 EVALUATION

Expert Evaluation

In this process, the instructor and other HCI experts went through the system design to inspect various design elements. Identifying design flaws which we should fix or redesign.

Expert evaluation is heuristic. They are expected to find these three kinds of problems:

- Cosmetic problems
- Usability problems that obstruct players from archiving intended goals.
- Functional problems

In the design stages, some problems were identified by the instructor. In our preliminary design, the players were supposed to control the paddles on the display by their body movements, and the paddles can only move in one dimension. We adopted the instructor's suggestions. The players can play the game with the rackets (sticks) directly, and the rackets (sticks) can move around freely. So the players can use their full-body motion to play the game. That makes the game more naturally and more immerging.

End User Evaluation

End User evaluation was mainly qualitative, designed to elicit feedback about the experience of playing E-Ball game. It includes the following aspects:

Functionality. Whether the system can provide proper functions to meet the needs of players.

Performance. Whether the system works well with the players.

- Bodily and spatial interface (body movements and interaction within the game)
- Learnability and intuitiveness. Whether the game is easy to learn and play.
- Physical interaction and shared experience between the players.
- Social interaction and shared experience between the players.

We used 6 subjects to play the game. A questionnaire was designed to cover the above topics. The subjects were requested to play our E-Ball game and a pure computer version similar game [11]. After playing the games, the subjects were asked to go through the questionnaire and check the proper items.

The questionnaires are designed as following:

Pre-Questionnaire

Before the experiment, the subject is requested to answer these questions (some of them are multi-choice questions):

- Gender
- Age
- Are you familiar with computer Games?
- Are you familiar with tennis, ping-pong, or hockey sport?

Post-Questionnaire

After the experiment, the subjects were requested to answer these multi-choice questions:

- How long did it take you to be familiar with the game?
- Do you think if the design of this game is successful?
- Compare your feeling of being entertained by physically moving in the game space in this system, rather than to play a computer game statically sitting in front of a screen?
- Compared with the similar screen based games, did this game offer a more exciting experience?
- Which type of game do you feel is easier for interacting with other players, the E-Ball game, or a networked multi-player game played with other players on a network?

6 RESULTS

The subjects include two 13 years old kids and 4 adults.

4 people are familiar with ping-pang or tennis games, and 5 people are familiar with computer games.

All the people could play the game skillfully after 3 rounds (about 30 minutes). 4 people thought the design of this game is successful.3 people liked to play a computer game statically sitting in front of a screen. All the people thought that the E-Ball game is more exciting than the similar computer game. And all the people feeled it is easer to interact with other players in this E-ball game.

7 DISSCUSSION AND FUTURE WORK

Generally speaking, the results from our user evaluations showed a positive user response to E-Ball game.

We noticed that there is a time delay between the movement of rackets and the actual "paddles" to hit the ball. Some times the image noises also make the actual 'paddles" tremble. The players' actions were seriously affected by those problems.

We are planning to use Local Positioning System (LPS) to trace the movement of rackets and use a faster computer to control the game. We expect the delay can be reduced to be unnoticeable, and the system performance can be improved dramatically.

8 CONCLUSION

E-Ball game combines the physical ball game (tennis, ping-pong and hockey) with the traditional computer game. In the game play, the physical body movements and the social interactions between the players are retained.

This system is easy to set up and the game is easy to learn. The response from the end users was consistently positive. All participants found it is more impressive and exciting than the similar computer game.

The E-Ball prototype could be improved by adopting a more accurate positioning system and faster computer. It also needs to be evaluated in E-Ping-Pong and E-hockey Scenarios.

E-Ball provides a proof of computer supported collaborative play (CSCP) and Social Computing (SC). In the nest steps, some computer graphics elements, computer game strategies and computer sound effects could be integrated with the system. This would create a more exciting and enjoyable system.

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