Airhockey Over a Distance

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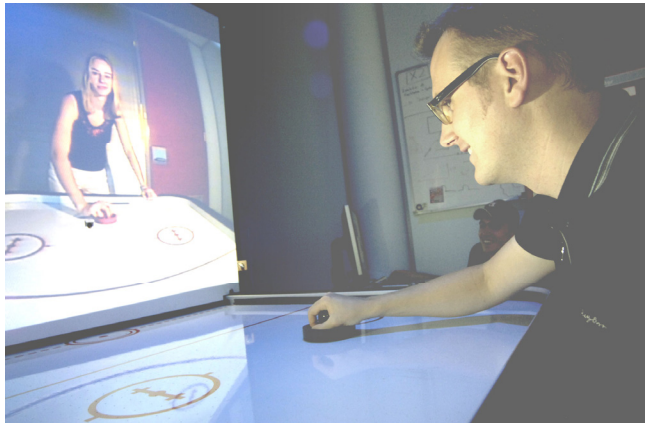

Figure 1. Airhockey Over a Distance (Photo by Andrew Tully, Sydney Morning Herald).

Abstract

In modern society, people increasingly lack social interaction, although beneficial to work and personal life. Airhockey Over a Distance addresses this issue by recreating the social experience facilitated by physical game play in a distributed environment. We networked two airhockey tables and augmented them with a videoconference. Concealed mechanics on each table allow for a physical puck to be shot back and forth between the two locations. Supporting the hitting of a fast-moving, tangible puck between the two players

creates a compelling social game experience which was confirmed by about 30 players. Our preliminary findings suggest that our casual physical game supports social interactions and contributes to an increased connectedness between people who are geographically apart.

Keywords
Air hockey, connectedness, social interaction, tangible interface, physical interface, exertion interface, videoconference, computer-mediated communication

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

Introduction

Social interaction is an essential human need. Our interactions with others are crucial for a fulfilling work and social life, and add meaning to our existence [10]. However, today people are often faced with the challenge of having to live and work apart from family, friends and colleagues. Today's lifestyle with its associated physical distribution of personal contacts and work arrangements decreases the chances of engaging in social interactions with friends and colleagues [10]. We are losing our sense of "connectedness" although it is "a potentially key concept in the […] development of communication technology" [12].

We are interested in enabling social interactions between friends and co-workers separated by distance. We started out by investigating where social interactions take place and came across social spaces such as pubs and community clubs where casual games including airhockey, pool, table-tennis, table football and darts can be found. Games have always been valued "as social experiences, as a way for people to relate to each other […]" [13]. In particular, these games can be enjoyed by novices and experts alike, need only a small space, are easy to learn and generally last only a couple of minutes; making them suitable as "ice-breakers", stress-relievers or time-passers. Unlike board games, these games are characterized by a physical interaction with a tangible interface.

Airhockey Over a Distance

We hypothesize that physical games are better in creating a sense of connectedness between remote players than networked computer games, as supported by Mueller et al. [7]. Their research on exertion interfaces allowed players to physically interact by kicking a ball. Even though this project showed that exertion interfaces more strongly support connectedness between players than virtual games, possibilities for increasing the sense of connectedness still exist. In their system, the players kicked two balls around, one on each side, but how would players respond if they could in fact "pass" a ball through the network back and forth between each other?

Airhockey Over a Distance aims to enable players to hit a physical puck back and forth between two networked airhockey tables [Fig 1]. It is played like a conventional airhockey game: two competing players are trying to score points in the opposing player's goal with a small round bat. The puck glides on a layer of air, pushed through hundreds of small holes, minimizing surface friction and thus enabling quick game play. In our implementation, the table is figuratively split in half and

the two ends are connected via a network. The players hit a real puck back and forth, trying to score a goal. Once the puck passes the midway-line, it is detected, and a corresponding physical puck is shot out at the other table.

Related Work

Airhockey Over a Distance demonstrates a novel interface in which a tangible, physical object replicates its appearance across a network. Unlike other networked tangible interfaces such as the PSyBench [3] and inTouch [2], where identical instances exist on both ends and only a state is synchronized, our approach allows the interaction object to exist only in one location at a time.

A project featuring a physical shared object that is passed back and forth is the throw and catch system described in [11]: A player throws a ball into a basket, a detection mechanism recognizes and transmits this information, and pops out a ball at the other end, creating a simple ball game between two players.

Sports Over a Distance is an attempt to allow two players to play a physically exhausting ball game together [6]. The authors define their "exertion interface" as an interface that deliberately requires physical effort [5]. The players exhaust themselves because they both kick a physical ball against a wall. The ball is not shared across the two courts, like with most other exertion interfaces, for example see [1].

Another airhockey game is AR^2: Two players wear head-mounted displays to see a virtual puck on a table. Unlike our approach, the game requires both players to be in the same physical location [9]. The authors suggest a vibration force-feedback device to simulate the impact of the puck; however, we believe the physical impact experienced in the real game is more exciting and creates the illusion of a shared space better than a vibration.

One of the first attempts of distributing physical activity over a network is "Telephonic Arm Wrestling", in which the player arm-wrestles the opponent over a phone line [14]. Also rather physical than social is the networked "Tug-of-War": At the New York Hall of Science two teams of high-school students were involved in a tug-of-war 13 miles apart from each other [8].

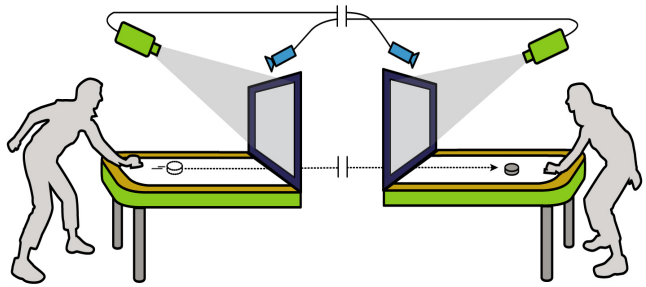

Figure 2. Conceptual design.

Implementation

Airhockey Over a Distance consists of two airhockey tables, half of each is involved in game play and connected via a network. The player is recorded by a camera and the video is displayed on the screen of the other player, creating the illusion of playing together on one table [Fig 2]. The videoconferencing screen is placed just above the table, and includes a camera, peeking through a hole in the projection surface. A projector placed above the table projects the video of

the other player onto the screen. We are utilizing a DV-quality codec implementation to guarantee a high-fidelity audio and visual experience between the participants.

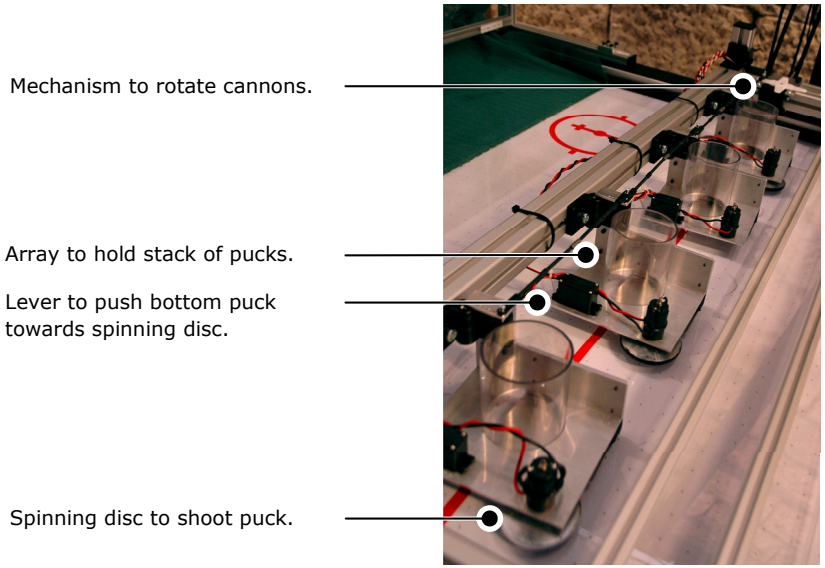

Figure 3. The rotating puck cannons.

If a player shoots a puck across the half-way line, it disappears through a small slot between the table and the videoconference projection surface. The puck is detected by a sensor detection system which triggers the networked control software. The puck is caught in a catchment tray and needs to be collected by hand at the end of the game. Once the software receives a command over the network, it triggers one out of four rotating puck cannons on the other table that hold an array of pucks [Fig 3]. These cannons hold enough pucks for several games, and a lever pushes the bottom puck of the array towards a spinning disc which can shoot the puck out at very high speed. All components were designed for rapid execution to minimize delays, and our preliminary tests showed that the system is fast enough for an enjoyable game experience.

Preliminary Findings

During a conference-like event, approximately 30 people interacted with Airhockey Over a Distance [Fig. 4]. We observed the players who played in two different parts of the building and conducted six interviews. We obtained participants' informal feedback and responses to the game experience. They responded with excitement and constructive feedback. Overall, the comments supported our prediction that the Airhockey Over a Distance system would foster a sense of connectedness.

Time constraints on production lead to a mechanical limitation of the system. During game play, the speed and position of the physical pucks were not calculated. Instead, the puck's position was randomly chosen and speed was a constant. The interviews and observations from the demonstration showed that participants were surprised and slightly bemused by the random angle and speed of the puck. However, the game was still enjoyable and the system clearly established a connection between the players. After playing the game, one participant noted, "This feels like my first salsa lessons… I'm slightly confused, but it's a shared experience to talk about." Another participant exclaimed: "If you could get pucks to line up, I think that's the only thing that's missing, other than that, I think it's pretty cool… very cool."

Participants were able to have a shared experience with the other players. An enthusiastic participant commented: "I'm taken with this... you could have a true interaction with someone, they could make you laugh, they could make you swear... that kind of interaction is unique, without abusing the word."

Figure 4. A participant playing Airhockey Over a Distance.

Future Work

Our next step is to formally analyze the affects of Airhockey Over a Distance on players' sense of connectedness to each other. In addition to the system with a shared physical puck, we have also built a vision-based version of a networked airhockey table. It utilizes the same videoconferencing technology and is played on the same physical table; however, the puck is not physical, but a projection on the airhockey table. The player uses a modified bat which includes a tracking system to hit a virtual puck back and forth.

We are planning a comparative experiment to study the interaction between the participants with the physical and the virtual game. We will study if the physicality of the game influences the interaction and if it can contribute to a perceived "shared space" between the remote players. This will allow us to better understand the significance of distributed physical interfaces on interactions between geographically separated participants.

Conclusion

We believe the physicality of the Airhockey Over a Distance game combined with its fast pace makes a compelling experience that has the potential to facilitate an increased connectedness between remote players. The physical and powerful action of hitting a real puck, its transformation into the virtual space and its physical reappearance on the remote end can contribute towards the perception of a mutual space in which the players interact. Although we are aware that casual games are only one way of supporting social interactions, we believe from the preliminary feedback we gained that this physical distributed game can facilitate an increased connectedness through social interaction between geographically separated participants.

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