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Seesaw: An Interactive Display To Facilitate Social Interaction

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Abstract

This paper introduces Seesaw—an interactive environment prototype that assists children to conquer common/potential fear during social communication in order to facilitate interactions that provide enhanced group-learning activities. Based on the games studies which emphasize children's psycho-behavioral and cognitive aspects, Seesaw aims at lowering the mental fears among 3-8 year old children, hence facilitating their social behavior. This prototype uniquely combines virtual reality and multi-touch technology. The design has been based mainly on the methodologies of tangible interaction design.

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1. Introduction

A range of children's interactive games featuring 3D Virtual Reality (VR) has been developed with not merely entertainment but also educational purposes for children in recent years. The flourishing of interactive and augmented technologies in recent years has been one of the major reasons that facilitate this tendency. Taking a closer look at the current market for children's interactive products, we can find a vast majority of games developed are based on the latest technology, such as 3D tracking [1], HMD (Head Mounted Displays) [1], Bluetooth, and touch screen [2]. To children, such interactive games not only serve as a medium which provides interesting graphics, but also help bridge the gap between reality and virtual world [3]. Based on the current technology, Bricken [4] proposed that the VR environment is experiential and intuitive, as well as being a shared information context for children's interaction.

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A market investigation focusing on several major market sharers VR games has been implemented based on Bricken's research about VR environment [4]. The success of these games rests on the following key aspects (Table 1):

- Immersive experience
- Intuitive interaction
- Shared experience

Table 1. Key success factors for major market sharers in VR market (2010-15)

Immersive	Intuitive	Shared experience
PlayART (2012)	Metamorphabet (2015)	Forest (2015)
Nosy Crow (2012)	Novel Hospital Toys' (2012)	Colour Chaser (2010)
Weather Worlds (2013)	Knock Knock (2012)	Puppet Parade (2012)
Crayon Creatures (2013)	Drawnimal (2013)	Visua Musio (2012)

1.1. Immersive

To facilitate immersive experience has become the key of success in this field. With the development of 3D-tracking technology and augmented virtual environment (AVE) [1], children nowadays can interact with the installations using gesture or their own body movement. In an immersive gaming environment like Weather Worlds (2013) and Nosy Crow (2012), children have control over the playing process through various proactive motions and gestures which enable them to gradually absorb certain knowledge as well as using them in the gaming scenario.

1.2. Intuitive

A virtual world enables users 'to move, talk, gesture, and manipulate objects and systems intuitively' [4]. Instead of merely staring at the screen, children now can interact with the high-tech device in a more tangible way. Both Knock Knock (2012) and Novel Hospital Toys (2012) deploy typical sensors to facilitate the interaction between user and physical object, enabling children to pick up academic knowledge in playful way. Intuitive interaction provides a natural way for children to interact with products, which enhances children's initiative to learn.

1.3. Shared experience

Virtual worlds allow 'multiple participants to interact simultaneously in the same environment' [4]. Forest (2015) enables the children to learn about Forest's development by engaging them to interact together with a giant tactile colour mixer [5]. Another typical technology to facilitate shared experience is 4G Long Term Evolution (LTE) [6] which enables children to gain real-time access to information resources. By a simple touch on the screen, children can share information with their counterparts through certain medium like smart phone, tablets and wearable devices.

2. Design rationale

The possibility of using the new technology to encourage social interaction among children has been emphasized through this study. And the feature of latest technology mentioned above indicates its potential usage for social connection. To rationalize the significance of our design, we have surveyed the design background and relevant user needs.

2.1. Social needs

Social anxiety and disorders are major social issues for young children and have been proved by epidemiological data as common childhood disorders [7, 8]. Too often, those who have anxiety disorders will have an excessive fear of social and/or performance situations. If let untreated, these children may even jeopardize the safety of families,

and in some cases, society at large when they become adolescents and adults [9]. For the development of children, social-emotional development has been taken into consideration in school education systems for its long-term effect of social behavior [10].

In the last decade, computer games have been widely accepted by all age groups. Gaming has also been used by mental health professionals as a method to complement traditional treatment [11]. Gee [12] proposed that game technology not only helps in exploring and learning concepts but also helps self-efficacy and awareness of social values [12]. Given its influence on connecting virtual life with real life and encouraging critical thinking, game playing may have a positive impact on children's social learning as well [3]. Despite the significance of gaming being used in social development, traditional user-centered design excessively focuses on HCI principles relevant for adults rather than for the needs of children [13]. Instead of using technology to communicate with peers, they may immerse themselves in the virtual world to avoid social connection. Indeed, current technology provides a platform to help release the stress among children, but the question we are asking in this paper, is: what is the best way to develop the interactions among children.

2.2. Children's needs

To better explore sound HCI methodologies for children and relate our design to social issues, we must expand our research to children's characteristics at the individual and social levels.

According to the theory of sensory integration by Ayres [14], the main reason children feel insecure and potentially stressed is they have not developed an adequate ability to ignore non-essential sensory information. 'Often, when young children feel anxious, they do not actually recognize or describe it as anxiety or nervousness' [15]. Instead, they experience anxiety as rapid heart rate, rapid breathing, sweating, or even trembling or shaking, chest pain and headaches [15].

Anxiety can affect children mentally and physically, hindering their communication with society. Yet despite their inability to communicate, children suffering depression initiate a greater number of interactions than did their non-depressed counterparts [16]; they are sensitive to stimulation and seek for sensory input. Compared with traditional games like puzzles, crafts and blocks, current children games have been developed to embrace varied sensory inputs including auditory, tactility and even olfactory, which have the potentials to satisfy the cognitive needs for anxious children.

In terms of social behavior, research has found that children playing on their own were more likely to switch among the games they often played than when they played in a group [3]. Another finding is that depressed children, despite their unwillingness to interact with the others, are approached by others more frequently [16], which should mean higher probability of receiving interaction information. Thus to develop a better interactive environment for children, the issues mentioned above should also be taken into consideration.

3. Design

The potential needs of users provide the prerequisite to embed social interaction elements into children interactive display. In this section, we envision an interactive system which facilitates interaction behavior of children 3-8 years old, and most importantly, develops their potential to communicate.

To develop the system from a social perspective, we based our design on a typical social context: waiting in a queue; first, because children in this context have the potential to feel bored, thus developing a sense of communication eagerness [17], second, during the waiting period, children tend to develop the anxiety of social communication [18].

3.1. Concept

Rather than initially focusing on visual elements, we aim at establishing an interactive environment which builds the social bond between children. The design goal is then about how to effectively build the interactive connection among certain child groups. Instead of simply presenting visual patterns, we wish to embody meaning in the patterns by making use of accessible information in the system.

After considering the overall scenario, our design focuses on two types of data: position and waiting time. Because these data mostly generate real-time behaviors of users, they may have more potential to evoke user empathy compared with the data collected from other studies.

We then envision a visualization system for the children, Seesaw, where the balance can be controlled by the dropping ball created by children. The size of the ball is actively changing according to the tapping time on the screen. Then the ball will drop down, affecting the overall balance in the Seesaw system. This system transfers the data about position and time to visible elements, presenting to the children the overall state of the waiting queue as well as dynamic information from the other players.

3.2. Technology

We built our prototype with Kinect sensor and projector. A short portable projector is mounted over the screen. A custom Actionscript program runs the game and is projection-mapped exactly onto the wall. Gestureworks is the current coding library (Fig. 2) used to embed interactive gestures (such as tap and hold) on the display screen. This project also supports real-time display using LTE technology to encourage long-distance communication among children (Fig. 3).

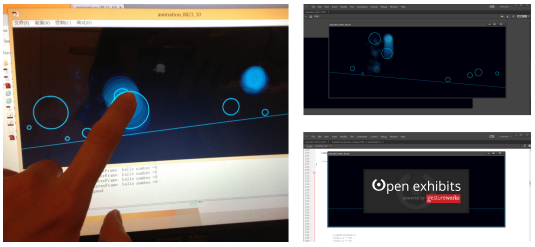

Fig. 2. Screenshot of Seesaw game

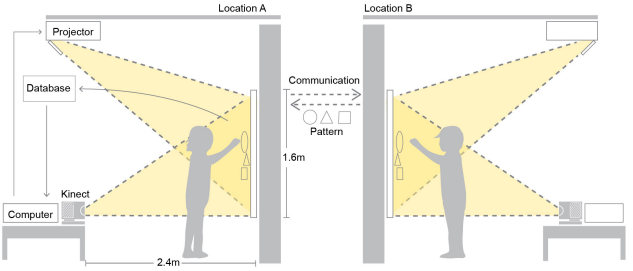

Fig. 3. System diagram

4. Interaction examples

Seesaw is not meant to be a stand-alone system, neither in its current iteration nor as a concept. The main objective is to create an interactive environment which will not only enhance the existence feeling of the other, but also reduce children's fear of social communication. To demonstrate its potential usage, we give three examples.

4.1. Competition and cooperation

This system has the potential to facilitate competition among children. The balance state of Seesaw encourages the players to build two competitive teams (Fig. 3). By controlling the balance of Seesaw, these two groups can actively try to win. At the same time, with a common goal at heart, children in the same team will try to cooperate with their peers. The competitive and cooperative behavior of children provides rich simulation, which satisfies the children's mental requirement for sensory input.

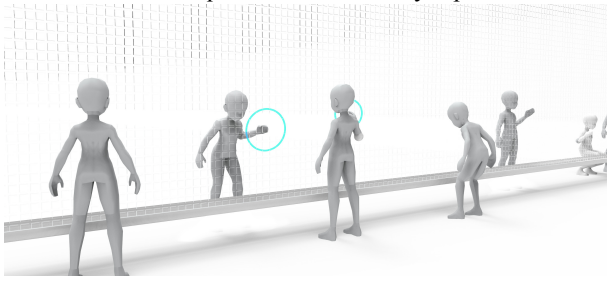

Fig. 4. Conceptual scenario

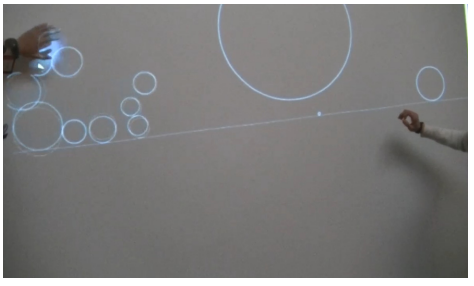

Fig. 5. Prototype of Seesaw for users to experience

4.2. Subtle interaction

Children in an anxious state are emotionally inhibited. To better involve the inhibited children into the game, we will try to avoid direct interaction like face-to-face communication or body touch. Instead, we will employ natural and subtle interactions in Seesaw, hoping to gradually assimilate the children into the game. One of the reasons we envision a seesaw as our design model, is its sensitivity to physical movement, as even a small object can control its balance (Fig. 4). Likewise, if we embody Seesaw in an interactive system, it may magnify the subtle interaction into a visible form. For instance, a tiny dropping ball can destroy the balance of the whole system (Fig. 5), conveying its existence to the whole waiting queue. We assume this practice would contribute to the early interaction stage, where the children's group still feels insecure [10] and shows protectiveness.

4.3. Timelapse

Since waiting is a relative temporary situation, we also try to symbolize this 'temporary' player status. We liken the temporary waiting activity to a shrinking ball, which would gradually decrease its size once created, then eventually disappear. This design enables the children to observe the 'leaving' of the other queue members, evoking empathy among the group. With the development of emotional connection, we envision children in the this stage would become less aggressive, developing an eagerness to communicate.

5. Discussion

A great number of products make use of newly developed technology for child development. To better illustrate our research potential and significance, we classify the current child interactive products into different categories based on the PLU model [19], which outlines children's purpose in interacting with technology. Then, after figuring out the typical categories of children's product in the market, we selectively survey two products which have the similar purpose and characteristics to our design.

Water Light Graffiti is a surface constructed from thousands of LEDs lit by contact of water or other physical objects. It engages children by eye-catching patterns and flexible interaction method. The other product, *Soarin* provides a unique approach for children to interact with a giant screen in Disney Land. The balloon in the screen will explode when players clap their hands. Both of these two products encourage multi-player gaming, make use of a big screen and have their own characteristics to engage children.

Indeed, both of these designs make good use of current technologies, however, they do not provide support for the development of social interactions between children.

- In *Water Light Graffiti*, children can draw patterns and interact directly with the screen, similar to the playing process of Seesaw. However, after creating the patterns, Seesaw provides a platform for these patterns to interact with each other by physical attributes like bounce, collision and strike, encouraging the children group to cooperate and compete.
- In *Soarin*, children have fun beating the balloon on the screen, yet according to our argument, we prefer the HCI process to be more subtle because children in an anxious state are hypersensitive to auditory and other sensory stimuli. Thus instead of clapping hands, we employ multi-touch technology to create a relatively calm environment, so as to involve children with social fear to interact with their counterparts.

We want to convey to the children that they are not just creating something amazing, most importantly, they are developing the connection with their peers. Rather than purely interacting with the screen, children using Seesaw have control over the whole system. By simply tapping on the screen, they create the elements that are not just visually appealing, but also have direct influence on the balance of Seesaw system, gaining real-time feedback and developing the feeling that they are intrinsically connected with each other.

6. Future work

This paper has suggested a potential social usage for Seesaw. We plan to continue this line of research by exploring further its long-term influence on child behaviors. Of particular interest is how the design can promote

social communication among children. In terms of educational usage, Seesaw also provides the platform for children to learn about physics. To examine the feasibility of Seesaw, more research methodologies are still needed.

6.1. Evaluation

A potential limitation of the current research is that, without empirical evaluation, the long-term influence of the system is still vague. As can be seen in Fig. 1, the anxious child is readily distracted; they may find it hard to participate in the same activity for long. Thus to engage these children, more variable design elements may still be needed. In addition, for a system that targets many users, the effects of Seesaw for the whole group is still unpredictable, because users differ vastly in behaviors and cognitive patterns. We would like to conduct further evaluation to explore if and how Seesaw could promote consistent engagement in the long run.

6.2. Behaviors

Individuals display vastly different subtle body behaviors when encountering anxious situation [9], which, in a degree, may reduce effective social performance. Nevertheless, from the perspective in this paper, we can hypothesize the possibility of using subtle behaviors (like tapping the screen) to facilitate interaction. We would like to study how different types of subtle avoidance behaviors can trigger interactions among children.

6.3. Technologies

The development of current technology does enrich children's daily life. However, we are trying to achieve the development of meaningful interaction among children, so that they can develop the potential to communicate. And instead of encouraging face-to-face communication, we prefer Seesaw to engage children in a more natural way. We believe current technologies like AVE and HMD have provided more possibilities to engage children, and in our future research, we will continue using new technologies to create playful and immersive environment, at the same time taking into consideration the development in social communication spectrum. Investigating which technology provides the best performance is beyond the scope of this paper and will be tackled in our future work.

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