i-PE: A Decentralized Approach for Designing Adaptive and Persuasive Intelligent Play Environments

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Abstract. This paper presents the approach of the intelligent Play Environments (i-PE) project. The aim of this project is to develop design guidelines for designing interactive environments that stimulate social and physical play. We want to create an environment that supports this play behavior and emphasizes on the flow of play by offering freedom in interaction. In this position paper, we describe our approach for designing such a play environment. We will introduce two focus areas for our research: playful persuasion and adaptation.

Keywords: Intelligent play environment, decentralized systems, open-ended play, playful persuasion, adaptation.

1 Introduction

The Dutch historian Huizinga describes play as a voluntary act, situated outside of everyday life, with no direct benefit or goal but capable of totally absorbing the player [7]. Within play, a temporary perfect world is created with its own boundaries and rules [7]. For children, playing is also a way of practicing skills and exploring imaginary worlds [2].

The i-PE project is a Dutch design research project that joins together knowledge institutes and creative companies and aims at stimulating social and physical behavior through play. We follow a research-through-design process in which we want to ground our design principles and better understand play dynamics in relation to interactive designs, resulting in design guidelines. We use the term Intelligent Play Environment for an environment "with one or more interactive objects that use(s) advanced technology to react to the interaction with the children and actively encourage children to play" [11]. Previous research has shown that interactive play objects can extend traditional play opportunities for children as they can allocate meaning to the diverse interaction properties [3].

In this paper, we describe our new approach to play environment development which combines decentralized systems and open-ended play. Furthermore, the focus areas of playful persuasion and adaptation are introduced as directions for further

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research. Overall, we believe this is a promising approach that can lead to both attractive designs and design guidelines. We will first provide examples of related work to create a non-exhaustive overview of the current state of art, both commercially and scientifically. Secondly, we will present our approach and two focus areas – as mentioned earlier – playful persuasion and adaptation. Then, we will illustrate these focus areas by two initial design ideas.

2 Related Work

In both the commercial and the scientific field many examples of interactive play designs can be found. This section describes several examples, relevant for the development of our approach and choice of focus areas.

Recent commercially available interactive play products focus on facilitating an environment where several pre-defined games can be played. An example is Sona (by Yalp). Sona (www.sonaplay.com) consist of a playfield and a large orange arch over it containing a camera. Sound feedback is used for a number of pre-defined games. These games mostly combine physical and social play. Multiple players compete against each other, e.g. in DanceBattle the players are divided over two teams and have to dance the best they can. This example shows some limitations of these products concerning the play opportunities: in order to play, the player has to choose one of the pre-defined games. Also, there is only one way to play the game; the system does not adapt to e.g. the amount of players or the personality of the player. The games have fixed rules with pre-defined possibilities. With our design, we want to go beyond pre-defined games and offer an environment that supports play and provides more opportunities for players to shape their play.

Fig. 1. Sona

Fig. 2. ColorFlare

The ColorFlare [3] is an example of an open-ended play object created for design research purposes. Players can roll the ColorFlare to change its color and shake it for flashing. In flash mode, the ColorFlare can influence the color of another ColorFlare using infrared communication. No game is pre-defined; players can create games by defining their own play rules. Although the open-ended aspect of the ColorFlare

offers many play opportunities, its behavior and interaction opportunities do not change during play. We think an adaptive design can offer even more diverse play experiences and stay engaging for a longer period of time. Furthermore, the ColorFlare does not attract players when no-one is playing. Only when children start to play, it becomes interactive. In that sense the ColorFlare is a rather non-inviting object.

3 Approach

In this paper we suggest a new approach for designing intelligent play environments. We aim at developing environments for open-ended play in which intelligence is embedded in spatially divided interactive objects. Below we discuss the aspects of open-ended play and decentralized system design.

When designing for open-ended play, the design does not offer concrete goals and rules but provides local interaction opportunities that lead to games the players create themselves [3]. Through this open-endedness the environment elicits a dialogue with and between the players. Players can create their own game goals and rules, and are stimulated to social interaction: negotiating ideas and interacting with other players. The system should follow what we call *the flow of play*. The term flow can be interpreted in two ways. Firstly, it refers to the flow experience of being totally absorbed by an activity as described by Csikszentmihalyi [4]. Secondly however, play has its own dynamics; it evolves in time. From this point of view flow refers to the overall play development instead of the user experience. With the flow of play we refer to the latter, although we expect the two are closely related.

We believe that a certain amount of intelligence is needed to cope with this flow of play, which has a high degree of uncertainty and unpredictability. With intelligence we mean that the environment can somehow sense certain factors of players and adapt to the current situation in the play environment. This is closely related to the vision of Ambient Intelligence [1], which describes five key principles: context awareness, embeddedness, personalization, adaptation, and anticipation. We want to propose a decentralize system approach. A decentralized system contains a number of separated autonomic devices that can somehow interact with each other or with the shared environment [6]. We expect that the scalable, robust and can be self-organizing properties of a decentralized systems, as described by [6], provide opportunities for the use in a play environments and fit the principles of Ambient Intelligence.

4 Focus Areas

Within the described approach we want to focus our research into intelligent play environments on the areas of playful persuasion and adaptation. These areas will lead to research questions for future exploration. In this section we will describe the two focus areas in more detail.

4.1 Playful Persuasion

Playful persuasion refers to applying playful mechanisms in a design with the aim to change people's attitudes and behaviors [10, 12]. These mechanisms can support playful experiences while users interact with the design, in this way persuading users to become physically and socially active. We believe playful persuasion can be used in the different stages of the play process [9]: invitation, exploration and the actual play experience, which we call immersion. These different stages are not always linear and some play experiences may not involve all three stages. These different stages can be linked to playful user experiences, such as curiosity, exploration and challenge [8]. Concerning the invitation stage, the design has to persuade people to actually become players. This phase is clearly linked to the playful experience of curiosity: the design elicits curiosity by being interactive and actively encouraging potential players to interact with the design. The exploration stage should give players the chance to investigate the rules and the playing field. This exploration, another playful experience, is supported by simple interaction opportunities and clear feedback. Lastly, the immersion stage should be challenging to be fun and stay fun for a longer period of time. Important aspects for this stage are time constraints and possibilities to give meaning to different interactions.

Possible research questions for this area are: How can curiosity be used to attract players to the playground? How can exploration be supported to help players understand the rules and interaction possibilities by playing? How can the play environment remain challenging for a longer period of time?

4.2 Adaptation

Play is an unpredictable process that cannot be captured easily in fixed scenarios [5]. We aim at designing a play environment with interactive elements that supports different types of play and which follows the flow of play. Instead of defining a system that supports one form of play, we believe the system should have adaptive properties. For example: a situation with several interactive elements can react slowly and timidly on quiet and slow forms of play. When players in this environment show more physical active play, the system can adapt by speeding up and creating more explicit output. The adaptive approach also fits to the described playful persuasion mechanisms; the different stages of the play process ask for other play dynamics.

Possible research questions for this area are: How can adaptation be used to support the persuasive mechanisms described above? How to design an effective adaptive environment? How to implement adaptive properties in a decentralized system so that it supports the flow of play?

5 Initial Concepts

Our aim is to design and build an intelligent play environment applying the approach as described above, with playful persuasion and adaptation as our main research topics. In this section we describe two initial ideas called *FlowSteps* and *Space*

Blocks. As a first step, we aim at a fixed play environment of similar proportion as a traditional playground, supporting physical play for various numbers of players.

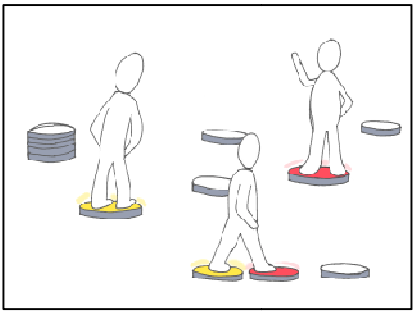

Fig. 3. FlowSteps

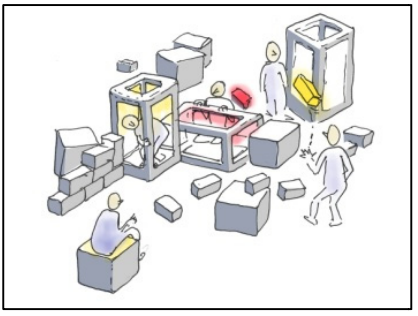

Fig. 4. Space Blocks

5.1 FlowSteps

Two boys like physical forms of play. One of them takes a couple of FlowSteps and makes a path with the mats. When he jumps on the first mat, the FlowSteps light up one after another. The other boy starts to run and tries to catch the light. They start to add more FlowSteps to their playing field. When they run faster, they notice it becomes harder to catch the light. Eventually they manage to catch the light, and they hear a score sound and give each other a high five.

FlowSteps consists of a large number of flexible interactive mats that players can use to throw, flip, jump or sit on. In this way, players can create their own games by placing the mats in any position they like. The design does not communicate a clear function; the embodiment is rather neutral. It provides players with opportunities to design their own play, creating playgrounds that support their diverse forms of play.

5.2 Space Blocks

A group of children enjoy playing fantasy games. Within the Space Blocks environment they are engaged in a serious fight with a dragon. One of the children yells: "We have to collect firestones and hide ourselves!" He starts picking up small blocks which twinkle in blue light, and crawls in a large hollow block. The others follow. The 'firestones' provide bright light flashes when they are thrown at the imaginary dragon.

Space Blocks is inspired by the notion that play can be created with loose material ("trash") lying around the playground. By offering different sizes of interactive cubes or rectangular blocks that players can stack, roll, throws, sit on or crawl inside, players can create a variety of fantasy and/or physical games. Within this idea, the embodiment of the objects becomes a much more important factor in determining the play opportunities.

6 Conclusion

In the previous sections we have discussed our design approach for designing decentralized play environments. We described two areas we focus on: *playful persuasion* and *adaptation* in order to design an environment that supports the flow of play in a natural way. For this, we use the research through design process. Eventually, this should provide us with design guidelines that can support the design of intelligent play environments in the future.

A next step is to further develop our initial ideas into one or more feasible design concepts and validate these designs with potential users. At this point we are extending our overview on the area of play design. We are interested in ways to analyze the playability of our designs and the quality of interaction. We are curious to see what different design approaches imply and how they conflict or complete our approach as described above.

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