Project Proposal

Body-Centric Interactive Play

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Abstract

Interactive playgrounds are installations where children can enjoy the benefits of both traditional playgrounds and digital games. These playgrounds are usually designed to encourage positive behavior in the players, such as being physically active while playing or interacting with the other players. However, not all interactive playgrounds manage to exhibit three key characteristics to provide the players with a rich, engaging experience: adaptation, personalization and context-awareness. We aim to develop a playground that promotes physical activity and social play, while exhibiting the three key characteristics mentioned before. We will center the interactions around the body of the player, sensing its movements and interpreting its actions to adapt and personalize the game to the behavior of the players. We plan to conduct an evaluation to assess whether the developed playground provides an engaging, immersive experience to the players and succeeds in maintaining them physically active throughout the play session.

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1 Project objectives

Play has been widely studied in human sciences because of its importance in children's proper development [6]. Since electronic games and consoles became widely used, there is concern about how much time children are spending playing electronic games indoors, the lack of free play and the increase in obesity levels [18]. In response to this trend, interactive electronic installations where children could play were designed to encourage physical activity, social interactions or cognitive development while observing engagement, entertainment and immersion levels [2, 15, 20]. In order for these installations to provide rich game experiences, three conditions must be met: adaptation, personalization and context-awareness [14]. Nowadays, however, most interactive playgrounds do not meet all these conditions. By centering the game experience on the body of the players, we are able to encourage physical activity and social interactions during play while increasing immersion and engagement levels [8, 11]. We will design **context-aware playgrounds that use body and behavior information to adapt and personalize game mechanics.**

This workshop will focus on how we can improve the game experience of players in interactive installations by following a body-centric approach. Four different contexts can be explored based on the number of participants and their preferences: (1) Games to play, use of online learning of dynamic game rules based on players' behavior; (2) Altered reality, combine active physical objects and augmented reality, the real world influences the virtual world and vice versa; (3) Interactive play platform, a large set of relatively simple open-ended play worlds each showing a specific subgoal: motoric development & physical activity, social interaction, technical possibilities and cognitive development; (4) Ambient persuasion, installation capable of persuading and adapting the play behavior of participants. Additionally, the target group (children, teens) will also be decided based on the participant's preferences.

We have the following objectives for this workshop:

- Improve techniques used currently in the development of interactive installations
- Explore new approaches in the field of body-centric interactive play installations
- Design a body-centric interactive installation that promotes physical activity and social play
- Provide the framework of the interactive installation as open source
- Create a basis for future research project collaborations
- Learn to design, implement and evaluate interactive installations in multidisciplinary teams

2 Background information

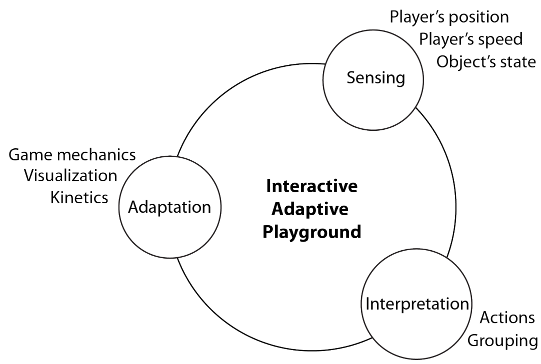
Interactive playgrounds are installations that try to improve traditional playgrounds by adding technological elements such as cameras or projectors to provide the children with interactive games. They are composed of 3 main elements: sensors (obtain information from the environment), actuators (provide feedback to the players) and gameplay (how the players interact with the playground). Interactive playgrounds can be placed in many locations such as schools [1], public spaces such as streets or stairs [4], or gyms to enhance training [5].

According to Schouten et al. interactive playgrounds should meet three conditions to provide a rich game experience: adaptation, personalization and context-awareness [14]. Most of them, however, do not meet the three criteria. For instance, in [19] and [9] players can personalize the games, but they do not adapt to the players as they are played. In [1], games are based on the creative rule making processes of children instead of implementing explicit goals themselves. This allows the players to personalize and adapt the game, but no context-awareness is present. In [16], Soler and Parés designed an interactive slide and tried to automate the measurement of physical measurement using cameras, but were not able to completely do so. In a recent study of the interactive slide, however, they succeeded in coarsely measuring physical activity levels of the groups by sensing the amount of movement of all the children [7]. This made the playground context-aware, but the information was not used to adapt the game. In the same manner, Ouchi et al. used pressure sensors to measure play behavior of children on an interactive climbing wall. They used this information to create a climbing model of the children, but there was no adaptation or personalization [13]. Derakhshan et al. used heart rate measurements to estimate physical activity levels in the evaluation of their playware tiles equipment [3]. In contrast to previously mentioned research, they used this information to adapt game mechanics to increase the children's amount of physical activity.

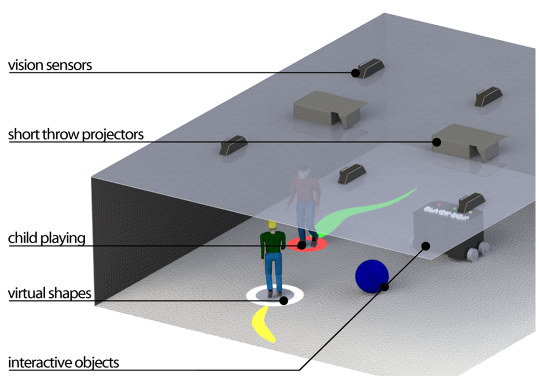
Besides providing a rich game experience, interactive playgrounds are also designed to promote physical activity or social competency. For instance, Wyeth et al. [19] designed the STOMP platform to promote social and physical interaction among people with intellectual disabilities. Tetteroo et al. [17] designed an interactive playground to stimulate physical activity, collaborative and competitive behavior. Metaxas et al. designed an augmented reality game, SCORPIODROME, where not only the virtual objects are influenced by the real ones, but also vice versa to promote collaboration and competition [10].

Ideally, playgrounds should provide a fun, engaging experience, and encourage positive behavior such as physical activity and social interaction. With the advent of new and affordable technologies such as Kinect or Arduino, achieving this goal is easier than it has ever been. Designing installations that are able to sense information about the players' position and motion, understanding behavior up to a certain extent becomes possible. This information could be used to adapt and personalize game mechanics in a playground to improve the game experience, especially when taking into consideration their prolonged use [12].

3 Technical description



An overview of the system that we envision for the workshop is shown above. We intend to use Kinects to track the movement of the players and accelerometers to detect the state of interactive objects located throughout the playground. We will use this data to interpret high-level information such as actions that are being performed by the players (jumping, running, etc), derive some social information (grouping) and identify player-object interactions (shaking, throwing, etc). The playground will be provided with this information, to adapt or change the way it responds to the players through the actuators in it. For instance, the game mechanics can change depending on the behavior exhibited by the children, the objects might provide different feedback, among other scenarios. The setup for the playground could resemble the one shown below.



3.1 Detailed description of tasks

3.1.1 Sensing

A grid of Kinects will be placed on the ceiling facing down to track the position of the players in the playground. Using their location, we can derive their speed and acceleration which will be useful in the interpretation stages. Interactive objects will be located throughout the playground for the players to play with. As they interact with these objects, accelerometers in them will provide us information in regards to their state.

3.1.2 Interpretation

Once the data has been acquired using the proposed sensors, high-level information will be derived from it. We will focus on recognizing physical actions and certain social behavior being exhibited by the players. The motion information of the players will be used to recognize actions such as running or jumping during play. Moreover, grouping behavior can also be recognized using motion along with location information. Besides this, interactive objects also provide data that can be used to interpret certain actions such as shaking, throwing, kicking. Other than what is mentioned previously, other actions or behavior could be recognized or analyzed depending on the progress made during the workshop.

3.1.3 Adaptation

The actions and movements that are sensed and interpreted are used to guide the interactions in the playground. Moreover, it will also be used to adapt and modify the playground during play sessions. The adaptation will address problems present currently in playgrounds when players are exposed for prolonged periods of time to the same mechanics. For instance, by measuring the physical activity of children during play, the playground might adapt the mechanics and visualizations to persuade the children to be more or less physically active depending on the measurements and goals of the playground. In the same manner, grouping information can be interpreted and then used to promote mechanics that persuade players to isolate or integrate other players.

3.1.4 Evaluation

Due to time limitations, a comparative test with end users will not be possible during the workshop. Likewise, evaluation of prolonged exposure to the playground not be possible either. Instead, we will perform a simple evaluation to show whether the interactive playground stimulates physical activity and social interaction. Organizing evaluation sessions with children is time-consuming and cumbersome, especially with non-English speaking children. Therefore, it might preferable to test the installation with students at the local university. Stimulation of social behavior can be evaluated with a questionnaire. Physical activity can be automatically measured with the developed tracking software. This will limit the necessity for manual annotation during the workshop but will show whether we attain our direct goals. Interviews can be used to gain further insights.

3.2 Resources

All software is free to use for research purposes. Some of the hardware (Kinects, Arduinos) can be provided by the project leaders. We encourage the participants to bring along their own laptops to work on. It would be convenient if the projectors and at least two mid-end desktop PCs with at least three usb-hubs would already be available. Also, a large space to be used for the set-up has to be arranged as well as space to work on, preferably separate of the interaction space.

3.2.1 Software requirement

- Microsoft kinect SDK / Libfreenect
- Microsoft visual studio express edition / QT creator
- Parlevision
- OpenCV
- A visualization library (openframeworks, ogre, jmonkey, etc)
- Arduino software

3.2.2 Hardware / Facilities requirements

- 6 Kinects
- 2 projectors (at least)
- Wireless arduinos sets / wiimotes / accelerometers / LEDs
- Projector mount solution (ceiling)
- Environment with dim illumination (6x6m)
- Speakers
- Computers and network connection

3.3 Project Management

The project leaders will be responsible for the global project management. During the first week of the workshop, the participants will be separated into four groups according (as best as possible) to everyone's personal interests. If there are less participants than expected groups might be merged. A team leader will be selected from each group and will be in charge of its management in collaboration with the project leaders. Each week, there will be at least two meetings to report on the progress of the groups, voice concerns and propose suggestions. The overall schedule can be adjusted based on what is discussed at the meetings.

4 Work plan and implementation schedule

The duration of the workshop is short and thus some preliminary work is expected before the official start. Participants need to read recommended literature and think about which group they would prefer to join. Most of the software that will be used is available online, so participants are encouraged to download it and start testing on their own. We will try to provide short tutorials to ease the setup and use of the software. At least two times a week a meeting with all participants will be held to keep the parts aligned with each other.

	All participants	Graphical representation	Play and interaction logic	Physical setup, electronics and design	Behavior measurement & interpretation
	Literature review				
	Software testing				
Week 1	Introduction and group selection	Framework setup	Concept and interaction specs	Object prototypes	Definition of recognized actions
	Hardware and software setup	Sketches	Communication protocol	Kinect setup	Analysis of expected data
Week 2	Detailed definition of concept	Presentation	WooZ setup	Sensor and actuators implementation	Basic action recognition
		Playtesting	Playtesting	Physical objects testing	
Week 3	Detailed evaluation setup	Improved visuals	Adaptive behaviors	Working installlation	Recognition of grouping behavior
	Begin combining modules	Interactive representation			
Week 4	Finish combining modules				
	Test & evaluation				
	Reports for eNTERFACE				

5 Benefits of the research

Current playgrounds tend to address only some of the three main characteristics that interactive playgrounds should have to provide a rich user experience. This workshop wants to contribute in bringing awareness to this fact. Additionally, we also want to explore ways in which we could implement an interactive playground that uses body-centric play to encourage physical activity and social play, while having the three main characteristics mentioned before. The expected products of the workshop are:

- A context-aware, adaptive, body-centric interactive playground that promotes physical activity and social play
- An evaluation of the developed interactive playground
- A report for the eNTERFACE proceedings
- Publicly available software

In addition to these concrete deliverables, the participants of the workshop will also gain insight on the process of designing, creating, implementing and evaluating interactive playgrounds. They will experience working in multidisciplinary groups, learn from each other, adopt new skills and putting them in practice throughout the duration of the workshop. Also, the software components produced during the workshop will be publicly available and free for use.

6 Team profile

Robby van Delden is a PhD candidate working on socially adaptive interactive playgrounds in the Human Media Interaction group at the University of Twente. His research focuses on two aspects of socially adaptive interactive playgrounds: the automatic measurement of social behavior, especially nonverbal synchrony, and the design of ambient entertainment installations that direct social behavior. His work is directed towards finding the right connection between sensing and inducing social behavior. He possesses two master degrees, one in Industrial Design Engineering (Emergent Technology Design) and the other in Human Media Interaction, both from the University of Twente. He can be contacted at r.w.vandelden@utwente.nl.

Alejandro Moreno is a PhD candidate in the Human Media Interaction group at the University of Twente. His current research is aimed towards the automatic analysis of human social interactions and tries to bridge together different fields such as computer vision, social signal processing and entertainment technologies. More specifically, he studies social behavior of children during play in interactive playgrounds. He addresses the problems of sensing children's non-verbal behavior during play and interpreting the social interactions they are engaging in. He received his MSc. in Color Informatics and Multimedia Systems from the Erasmus Mundus CIMET program. He can be contacted at a.m.morenocelleri@utwente.nl.

Ronald Poppe received a Ph.D. degree in Computer Science from the University of Twente, the Netherlands in 2009. He was a visiting researcher at the Delft University of Technology, Stanford University and University of Lancaster. Currently, he is a postdoctoral researcher in the Human Media Interaction group of the University of Twente. His research interests include the analysis of human motion from videos and other sensors, the understanding and modeling of human (communicative) behavior and the generation of communicative behavior for virtual characters in human-computer interaction. In 2012, he received the most cited paper award from the "Image and Vision Computing" journal, published by Elsevier. He has (co)organized several workshops and special sessions on behavior understanding and motion analysis at IEEE Face and Gesture Recognition (2008 and 2011), IEEE Computer Vision and Pattern Recognition (2010), Intelligent Environments (2011), Intelligent Virtual Agents (2012) and Measuring Behavior (2012).

Dennis Reidsma is Assistant Professor at the Human Media Interaction group and Lecturer of the Creative Technology curriculum at the University of Twente. After receiving his MSc degree in Computer Science cum laude for a thesis on semantic language processing, Dennis Reidsma completed his PhD degree at the Human Media Interaction group of the University of Twente. His PhD thesis, titled Annotations and Subjective Machines of annotators, embodied agents, users, and other humans, deals with problems of annotation and reliability in large multimodal annotated corpora, and especially the relation between reliability and annotator agreement on the one hand, and the subjective nature of many annotation tasks in the field of human computing on the other hand. His current research activities focus on two main topics. He supervises a number of BSc, MSc, and PhD students on topics of computational entertainment and interactive playgrounds, runs several research projects in this area, and is regularly involved in the organization of conferences such as INTETAIN and ACE. He can be contacted at d.reidsma@utwente.nl.

Other researchers wanted

Participants with expertise related to any of the 4 topics that are going to be analyzed are welcome. Depending on the number of participants and their expertise, some groups might be developed more extensively, whereas others might be merged with other related group. Topics where expertise is welcome are:

- Entertainment technologies
- Computer vision
- Artificial intelligence
- Programming interactive systems
- User experience evaluation

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