iTheater Puppets
Tangible Interactions for Storytelling

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Abstract. In this paper we present preliminary work on iTheater, an interactive integrated system for story-creation and storytelling, dedicated to young children. Based on the analogy with hand puppets' theatre, the system aims to create an interactive environment where children will be able to give life to their imaginary characters by creating, editing and recording computer animations in a simple and exciting way, through the movement and tactile manipulation of traditional hand puppets. The system merges the familiarity of use of physical objects with the engaging richness of expression of sounds, images and animations. The iTheater is conceived as a creative flexible toolkit to create and tell stories, taking advantage of the new opportunities based on the multimedia and interactive technologies.

Keywords: Tangible interfaces, children, puppetry, edutainment, new hardware technology for interaction and entertainment.

1 Introduction

Puppets are a powerful interface to fantasy and creativity. Its use provides a great potential to educators when working with children and their immediateness and simplicity makes them friendly and engaging. Besides, puppets provide children with a mean for expressing and experiencing emotions and interacting with other pairs.

All the physicality embedded in the use of puppets can be exploited as a tool for producing creative expressions. These expressions may vary from a projection of own thoughts and emotions through storytelling, to assimilation of the external stimuli through introspection. In this way, puppets could be used as a mean for reflecting and interpreting the perceived world and therefore as a way to bridge reality towards the internal cognitive processes of individuals. Based on the previous reflections, we can intuit the potential of puppets use in different cognitive experiences like education, cognitive therapy and artwork creation among others.

In this work, we propose iTheater as a way to expand the creative possibilities of puppets through the creation of puppet-like tangible interfaces augmented with embedded sensors (e.g. RFIDs and accelerometers) and multimedia capabilities integrating the different elements of a traditional puppets-theater (e.g. play setting, music, lighting, etc.) into a virtual representation. In this context the resulting tangibles

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would provide direct manipulation of physical objects enriched with more means of interaction and with persistence of actions in the digital world for further analysis.

In particular, the iTheatre takes advantage of the various aspects of puppetry for stimulating the user:

- *Puppet workshop*: the physical manipulation of the puppet, its creation, personalization and characterization, corresponds to the character creation in the multimedia piece of art.
- *Process drama*: the process of play creation by it self is full of opportunities for learning and creative work.
- *Make and believe*: tangible elements make it possible to the child to enter in the story and in the character
- *Storytelling*: the final result can be reviewed, manipulated, refined.

Besides the traditional advantages of using tangible interfaces with children, we should also add its versatility in catching all the expressiveness of gestures and richness of non verbal communication that otherwise would be lost. Indeed, when playing with a puppet, the borderline between the puppet and the kid's hand that is moving it is blurred: the puppeteer's hand is part of the puppet, but at the same time the puppet is an external entity. This that allows a great range of expression and non verbal communication, allowing to express feelings like aggressiveness as well as tenderness, stressing the make and believe effect, and giving to the child the sense of mastery.

2 Related Work

Based on the use of real puppets and other tangible representations of screenplay elements, iTheater allows children to have full control of the story. This is relevant according to the children needs pointed by Druin et al [4] regarding their interaction with technology - control, social experience and expressive tools - and in the fact that technology should support children's curiosities, love of repetition and need for control [5].

Traditional toys can be augmented in order to being used as tangible interfaces. Today children are used to interact with toys that are basically TUIs: indeed modern interactive toys have tactile interfaces, produce visual, audio and physical feedbacks, can be combined in various ways and sometimes 'programmed'. Objects such as soft and plush toys, puppets, etc., if used as TUIs allow children to interact complex systems in a very natural way. This is specially true for small children because we would use the objects that naturally attract their attention and curiosity. However, when a toy involves the child in a passive way, it is not able to support the child in their creativity. For example plush toys that tell stories do not support the child creating his or her own story. As Cassell and Ryokai point out in [8], these toys do not "empower them to express and create or co-create…and to use their imaginations."

An example of the use of child toys as TUI is the Rosebud [10] system, where toys based TUI is used in addition to the traditional graphical user interface (GUI). The

child interacts with various toys and with a computer. The child tells his story his toys and the audio is recorded by the computer and associated to each toy. The software also generates the story-specific feedback and encouragement. The physical toy is enriched by the stories created the child, and the possibility to exchange it among children allows collaborative story creation.

In Storymat [8], toys based tangible interfaces were used for creating an familiar interactive environment where children could feel comfortable in telling stories making the storytelling very natural and easy. Children can play and tell stories on the Storymat using several toys and the mat itself (representing the world), "Storymat captures the stories, the motion of the toys, and the place they were told, for them or other children to see and hear later". In listening to the stories of others as well as their own, children react by telling more stories and telling stories collaboratively.

Another approach TUI based story telling can be found in Gorbet et al. [13] where the authors present *The Triangles* tool, that allow through the use physical building blocks (shaped as triangles) to create various applications based on object manipulations. One example of usage of *The Triangles*, is an application for interactive non-linear storytelling: depending on how the triangles are put together, different web pages or audio files are presented or played. Even if the results of the manipulation are shown in a traditional way (web pages and audio files), this early work already show how much physical building blocks can become "powerful tools for thought and play". The story telling example applications of *Triangles*, "provide a very simple means for interacting with a potentially very complicated set of character relationships and storytelling situations." These applications work with pre-configured story paths, but the use of physical building blocks allow users to use the application in a very straightforward way. This work shows how it is possible to exploit the physicity of the objects (in this case the triangle shaped blocks) and its affordances to give the user the actual feeling of holding and manipulating the content.

Other collaborative story making systems are the TellTale [14], and the DollTalk [15]. These story-making tools are based mostly on audio recording, without the use of computer graphics or animation that could enrich the final story. Kids Room [16], SAM [17], and ActiveCube [18] add the use of images and animation to record the story.

3 Envisioned Application Scenario and Education Goals

Besides of being entertaining and engaging for the children, iTheatre is designed for being an efficient and customizable tool for educational purposes. The system is conceived to provide a novel fertile tool both for educators and children to foster the crucial passage in learning from spoken language to written language, that, as E. Ackermann stresses in [3], can be a difficult one, "not just for children who grew up in dominantly oral traditions but, closer to home, for *digital* kids."

Storytelling and role playing encourages the child to develop his/her narrative skills, learning to contextualize a story, to organize ideas, keeping trace of a speech and elaborate the elements of a story [1]. Tangible interfaces have the role of facilitating this process, allowing children to naturally be engaged in playful interaction while creating the story.

The system will be evaluated in real scenarios such as schools and museums. To this aim, the iTheatre project involves teachers and educators with previous experiences on the use of new technologies in educational projects, with whom collaborate in the development of the interface and tool, working on usability/customizability/intuitiveness of the interface and on the design the interface best-suited for the specific activity of story creation. Besides, the ongoing collaboration with the local Natural Sciences museum (*Museo Tridentino delle Scienze Naturali*) will be important in the evaluation phase, for attracting users in a real context.

4 iTheater Description

The iTheater is an interactive integrated system for story-creation and storytelling based on tangible interfaces and animation editing, dedicated to young children of 4 to 8 years old.

iTheatre use a familiar context, the puppet theatre, for enabling storytelling as a game. Since the puppet theatre is also a social game that often involves more than one puppeteer and an audience, the collaborative involvement comes more spontaneous. The story created with the puppet do not have only an oral component but also a visual component given by the acting of the puppet that is translated into an animation on a video clip.

The iTheatre is characterized by two main complementary components:

(a) the core *Puppet Interface* for the control of one or more virtual characters;
(b) a set of physical objects constituting a *Tangible User Interface Toolkit* to perform the activity of animation-editing through physical intuitive objects.

The system is schematized in Figure 1, with a special highlight on the functional block tangible user interface.

The use of TUI allows to capture the expressiveness and creativity characteristic of the immediateness of the playing moment and use this material for creating content,

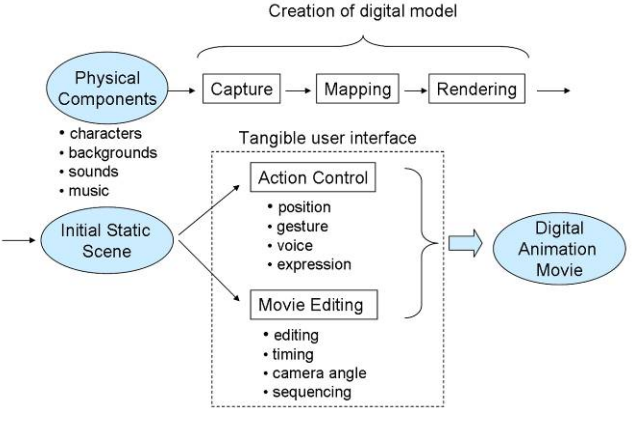

Fig. 1. Relationship between iTheatre components

based on animation techniques, that can be reviewed, modified and refined afterwards. The resulting system encourages creativity and expressiveness through the puppet interface and at the same time makes the complex task of animation editing easy and natural through the manipulation of physical objects though which create associations, control functionalities and manipulate multimedia material. Children can manipulate content in a very simple way, as if they were playing with toys in a playground, while the technology is completely hidden to them.

A particular emphasis is be given to simplicity, ergonomics and low-cost of the solution, based also on a deep analysis of user requirements. Participatory Design is used, taking into account both children and educators as final users.

4.1 Early Prototype

In order to have a quick first feedback from the teachers and educators that take care of the pedagogical design and assessment of the system, a basic prototype system has been developed (Fig.2).

The *Puppet Interface* was implemented using an IR vision system. Hand puppets were equipped with two infra-red (IR) leds placed on their arms. Puppet's movements were tracked by an IR camera able at the moment to recognize up to four IR lights, so that two it was possible to use two hand puppets at the same time (for this prototype we used the IR camera embedded into a Nintendo Wiimote Controller), allowing two users to play at the same time. The movement of the arms of the puppet are then tracked and interpreted. Movements that the user perform on the puppet are translated into various actions of the virtual character, including visual and audio effects, giving life to the virtual character. For this prototype, four pre-defined characters were created: *the princess, the bubble man, the pirate* and *the dragon*, with their own set of animations and audio effects. In addition to the movement of the virtual character in the screen, the player can induce his virtual character to perform pre-defined actions, depending on the profile of character chosen by the user. For example with a fast moving movement of the arms, the player can make *the dragon* to fly, or *the pirate* to fight, giving additional creative possibilities to the player.

Fig. 2. iTheater components

The *Animation-Making Toolkit* was implemented using as interface various objects with embedded RFID tags (in the example in fig.2 we used playing cards). Manipulating these objects, the user is able to set up the virtual puppet theatre and access to various functionalities. The player can use this interface for choosing his character and define the story context, for example adding/removing backgrounds (both audio and video), adding music effects to the narration, choosing style, etc… Selected objects (in this case playing cards) are collected on a bowl equipped with an antenna that reads the embedded RFID tag, allowing the system to recognize the user's choices and to set up the virtual puppet theatre.

Even being quite simple in its implementation, this first prototype met his objective of illustrating the concept behind the iTheatre system and received encouraging positive feedbacks.

5 Preliminary Users Feedback

Previous work on users requirements analysis has shown the difficulties of users for expressing requirements they are not aware of. This situation is typical in the development of emerging technologies [6]. One approach to mitigate this problem is the use of early prototypes that can give more concrete schemes and representations of these new technologies [7]. These assumptions motivated the development of the iTheater early prototype that is subject of this paper. In order to obtain preliminary users feedback for steering the future development of iTheater, we conducted the users study presented in this work.

The study was conducted with 10 users (5 Male and 5 Female) with different background (5 administrative workers, 4 researchers, 1 child;) and different age ranges (1 [< 10yy], 2 [20-25 yy], 4 [25-35 yy], 1 [35-45]yy, 2 [>45yy]) organized in three main stages: 1) demonstration of the main functionalities of the prototype, 2) direct usage of the iTheater prototype by users and 3) an interview based on a questionnaire regarding use and potentials of iTheater. Figure 3 shows two moments of the interaction of users with iTheater.

Fig. 3. Users interaction with iTheater system

The summary of the obtained results are shown in table 1.

Table 1. Users study summarized results

Familiarity with iTheater technology From the analysis of interviews it was found that 7/10 users didn't found any similarities between iTheater technology with other systems they used in the past. However, the other three users recall their use of Nintendo-Wii as a similar technology stating as a main difference the fact that iTheater allows for more development of creativity while Nintendo-Wii was identified as a rather "close" system where interaction is more tight to predefined scripts (surprisingly the kid was one of this users that expressed iTheater can allow for more creativity "you can invent your own stories")..
General impression of iTheater prototype All ten users expressed their likeness to iTheater prototype and six of them highlighted the potential of iTheater as a tool for developing creativity through richer storytelling means (involvement of audiovisual stimuli, physical interaction and eventually collaboration with other people). In general the system was perceived as "fun" and "entertaining".
Proffered/desired features: During the interviews four features of the iTheater prototype were highlighted as the most interesting ones. The features are ordered according to the highest number of times that it was perceived as the most desirable one : 1) Virtual characters movements when moving physical puppet . Each character had three different states of movement when played (e.g. walk, sit, jump, etc.). 2) Manipulation of physical objects – effect in virtual world (e.g. physical drawings associated to virtual scene, physical objects associated to sound effects, etc.) 3) Interchangeable scenography and 4) Interchangeable audio effects and 5) multiple puppet interactions.
Difficulties of usage All users recognized the system as an early prototype but highlighted the need to keep special attention when developing the final system on making the interaction easier. Indeed the current prototype require smooth movements of the puppets in order to be recognized and that was non immediate for users while interacting with the prototype. However after the first movements of the puppets users came naturally to move them slower to see better correspondence between physical movements and associated movement of virtual characters. Another relevant finding was the expression of users to use only one puppet in one hand while keeping the other hand free for manipulation of other objects such as the scenography, audio effects objects, etc. People wearing two puppets simultaneously show difficulties for doing such manipulations.
Potential applications for iTheater technology Users manifested different potential applications of iTheater technology. The preferred potential application for iTheater was found to be for training and education. Other applications came out from the interviews such as the development of interactive toys, computer games and even as a tool for augment experience while shopping (e.g. supermarket) by manipulating products and obtaining more detailed descriptions in distributed displays.

The results show that iTheater users were able to express more concrete requirements after interacting with the prototype. In addition, the elicitation of the requirements was greatly simplified by the discussion with the experimenter mainly because they were grounded in practice and experiences. In any case, the requirements that came out from usage were still strongly related to the actual functionalities of the current low-fidelity prototype and only in few occasions were completely original. Thus, even if useful as a tool for early evaluations and identification of potential requirements, the use of low-fidelity prototypes may bias users' to focus more on current functionalities than in expressing new ones. Further work will consist in focusing on definition of new users studies motivating identification of new functionalities and requirements taking as starting point the findings of this study.

6 Concluding Remarks and Future Work

The preliminary work on iTheatre and the early involvement of users representatives allowed us to explore the many potentialities of our approach.

Furthermore, we believe that tangible interfaces are a powerful tool to fully exploit the physicality of the puppet theatre with all its creative richness, and the children confidence with puppets allows reduce the barrier to learn this new interface. Even if this specific research work is dedicated to a specific learning domain, findings from experimentation and system evaluation could open to many possibilities not just for edutainment projects but also for other application scenarios based on puppet theatre such as therapy and art creation. These include collaborative approaches to the iTheatre, such as remote multi user play creation and story-telling.

Future developments of the tangible interface will include the use of more sophisticated motion capture techniques, the possibility of customizing characters, the possibility of using user created content (e.g. background and sounds), recording the voices from users while playing their story, and the possibility of manipulating the story after creation.

After the preliminary positive results, we envision, for the next prototype version, to organize a more extensive user studies focused children, in order to obtain more targeted results and feedback.

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