Merry Go Round: a Physical, Virtual, Physical… Toy

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Abstract
We present a mixed-reality interface, in which a carrousel-like platform carries a set of wooden figures from the physical world into a game running inside a tablet, bringing them back to the physical world again by further rotating the platform. The wooden figurines allow young children to manipulate and play with them, working at the same time as characters of a game. Along the interaction, users are confronted with different problem solving situations that they can solve with the help of the wooden characters.

Author Keywords
Tangible Interaction; Children Interaction; Magnetic Field Sensor; Touchscreen Devices; e-books;

ACM Classification Keywords
H5.1. Multimedia Information Systems: Artificial, augmented, and virtual realities; H5. 2. User Interfaces: Prototyping

Introduction
Rich contexts and situations stimulate children's natural need for exploration and discovery [7], thus offering an enormous opportunity for the development of innovative materials that promote learning and engagement in the early years. Board games, card games, dolls, toys, learning materials, books, are all

transitioning from the physical into the digital realm, supported by an increasing variety of easy to use and affordable tablet devices. However, discussions about the design of technology in this context, have disclosed how technology often fails to exploit the affordances of the medium, by merely transposing traditional materials to the corresponding electronic format [5].

This work is part of an ongoing project that seeks, with a "no batteries/no wires" philosophy to connect traditional toys and physical objects to the novel tablet interfaces, reinsuring that the physical interaction is central to children's experience with technology.

Concept

The concept behind this work was the creation of a platform (a carrousel-like round table) that targets young children and explores the illusion that wooden characters can suddenly become alive when they disappear behind a device's screen placed on the platform (fig. 1). While building from a "naïve" illusion, the intention is to create a simulation environment to promote an experimental, participatory and active involvement. The physicality of the characters allows children to manipulate and play with them, alone or with their peers, while at the same time the characters become interactive, creating an immersing world and further extending the experience of play.

Figure 1. Top view of the interface and the wooden characters.

Throughout the interaction, children face a range of different problem solving situations, which they need to solve with the help of their physical play characters. The decision to address problem solving emerged out of the knowledge that engaging in such activities demands analyzing the requirements of the tasks and choosing the adequate resources to address them, thus promoting reflection, agency, autonomous thinking, intrinsic motivation, and action strategy [2, 8], therefore enhancing learning autonomy and self-confidence.

Background and Related Work

The approach to extend the physical interaction into the virtual environment builds on previous works such as the Magnetic Appcessories [1], the Bridging Book [4], or the TOK platform [6]. The Magnetic Appcessories uses magnets embedded on various objects to control digital information. The Bridging Book is a children's picture book that consists of a printed book with embed magnets and a digital device with synchronized content. Thumbing through the book triggers the digital content displaying it on the iPad, extending the printed illustrations on the book into the device's screen, offering further interaction. TOK is a tangible interface for storytelling, where children can create their own narratives by placing tangible picture-blocks on an electronic board, which then trigger the corresponding animations, displaying them on the screen.

The interface presented here differs from previous work by combining two interaction levels, as children can use the tangible wooden elements to interact with the digital content, and at the same time they can navigate in the virtual world using the devices screen. In the following section we provide a detailed description of the system.

The Interface

The interface consists of a set of tangible wooden characters, a rotating platform with an integrated support on its center for placing a tablet device, and a hidden area located behind the device (fig.1-3).

Figure 2. Physical animals become digital characters

Figure 3. Interface with a figurine placed on the platform.

The interaction with the digital content is done both through the physical elements, as well as by touching the digital device, triggering different animations and audio feedback. The wooden figures come to life virtually when they disappear behind the tablet device, and as long as they remain in the hidden area. Further rotating the platform brings the physical figurines in sight again, while their virtual equals vanish from the screen.

Technical description

The platform has three hotspots with embedded magnets for placing the tangible figurines (fig.4); similarly, each tangible figurine has a magnet embedded on its base. Using the readings of the device's magnetometer, the figurines can be identified and distinguished through the magnitude of the magnetic field in the area around the sensor, since each one has a different force. When the platform is rotated and a hotspot passes near the right edge of the device, a dedicated application detects a change in the magnetic field, identifying it as a determined object (when a figurine is placed on the hotspot), or instead as an empty spot (in case no figurine is placed on it). These detection events are translated into digital actions such as animations, sounds and interactions, corresponding to the entrance and exit of the objects in the hidden area. This technique based on magnetic detection allows the interaction around the device without the use of any kind of external electronic solution, keeping the production costs low and taking advantage of the device's capabilities.

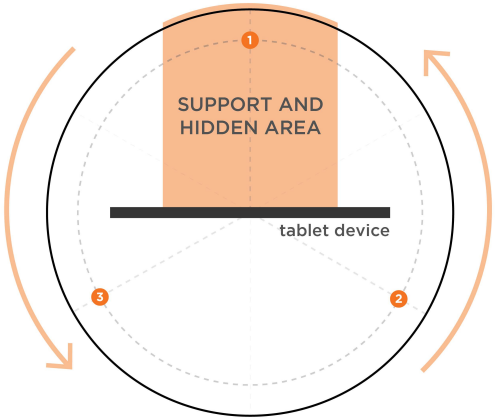

Figure 4. Interface top view with location of the tablet device, support box and magnets (numbers 1 to 3).

However, this approach has some constraints such as possible external magnetic interferences that can lead to the misread of the magnetic data and consequent malfunction of the application.

Interaction Models

We propose two interaction models for this interface taking in consideration that only one character at a

time is inside the game. In the implemented model, the user is asked to choose the best wooden figure to solve each challenge posed by the application. The figure is placed on the platform and rotated into the game, gaining life on the screen as an animated character. Only one figure is able to provide the right solution, which will then move the game forward to the next challenge. Nevertheless, there are funny, unexpected consequences designed to keep up the interest and encourage exploration when choosing a different wooden figure. Additionally, we are exploring a different interaction model, in which each wooden figure is able to trigger different content or narrative branches. This interaction promotes the change of characters, opening up storytelling possibilities and experimentation with alternative scenarios. In either case, the tangibility of both the figures and the rotation platform support and promote collaborative play, allowing children to interact and explore the content with their peers, providing opportunities for social interaction and exchange of experience [3].

Further Development

The interface is still in an early development stage; further development includes increasing the number of the hotspots, allowing using multiple figurines simultaneously, as well as further developing the digital content, creating a variety of different subjects that allow the exploration not only of problem solving activities but also other subjects. Moreover, by exploring different interaction models, we aim at targeting older age ranges.

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