M&M - MONNOM meets MOBEYBOU

Digital Interfaces for Children's Embodied Interaction

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ABSTRACT

We present M&M, a digitally enhanced narrative environment for children that resulted from the collaborative projects Monnom and Mobeybou. M&M aims at offering children open-ended interaction scenarios to collaboratively create narratives through their bodily movements, voices, and the use of physical objects in space. M&M consists of sensors that collect data from the physical environment, an operating system that transforms the collected data into digital visualisations, and a projection that displays the output of the narration. In the physical environment, children can use objects and move with them to interact with the digital narrative **elements.** By interacting with the story elements, children connect with different cultures and environments, in an intercultural embodied storytelling experience.

CCS CONCEPTS

• **Human-centered computing** → Human computer interaction (HCI); Interactive systems and tools.

KEYWORDS

Spatial experience, Interactive Narrative, Active Participation, Bodily Experience

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1 INTRODUCTION

M&M is a novel digitally enhanced spatial environment for children's active narrative processes. It is an interactive storytelling system designed for children, which was developed from the intersection of two existing systems: Monnom [8] and Mobeybou [19], in a collaboration between two research teams with common interests but different backgrounds. M&M aims to develop a model for integrating the physical space and digital media in children's experiences. The focus is to create an open-ended environment where children can move in freely with their objects, creating their own narratives in both digital and physical environments. Our target audience are children aged between 4 and 12 years as well as educators working in museums, schools, kindergartens, after-school programs, and other formal/ informal learning environments interested in supporting children's narrative experiences through bodily engagement with their surroundings while interacting with the digital environment. In the following, we present the theoretical framework that underpins the development of the system, and a brief description of Monnom, Mobeybou, and the first M&M prototype. We then report results from a small pilot study followed by a concluding discussion on the limitations of the work and present future plans.

2 THEORETICAL FRAMEWORK

The idea behind M&M is sustained by the role of storytelling in children's development, the role of objects in scaffolding cognitive processes, and the notion that the body plays a fundamental role in our thinking and reasoning as explained by embodied cognition.

Storytelling is a powerful tool for children to communicate their creativity, providing opportunities for creative thinking [14], socio emotional development and social interaction [7, 18]. Stories are fundamental in helping children to make sense of their experience and in the development of cognition [4, 5]. They promote children's curiosity about the world, their acknowledgement and acceptance of diversity, raising children's empathy with others by introducing them to characters, to their lives, motives and feelings [14]. Objects have a major role in stimulating children's creativity, scaffolding cognitive processes and the development of cognitive structures [1, 3, 10, 13]. An important dimension in the design of this work was to bring together the physical and the digital experience. According to Robinson [15], there is an intimate relation between tools, materials, and human cognitive processes: "Creativity is a practical as well as a conceptual process: how and what we create has much to do with the tools and materials we have available, and what we make of

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and with them" [15: ix]. Likewise, the role of sensorimotor action in cognition is well established in multiple disciplines and strands of thought [6, 12, 17, 21]. Glenberg affirms that "all psychological processes are influenced by body morphology, sensory systems, motor systems, and emotions" [6]. Research has also shown that besides the body, cognition is configured by the use of resources (tools, artefacts, materials) and by our interactions with others, which are external but connected to the individual's thinking [11, 16]. Through their double function, tools can "extend our bodies" and "expand our minds" [15: vii]. When interacting with M&M children can freely express themselves and create their narratives using their body movements, the available physical objects act as additional triggers for experimentation and collaborative narrative creation.

3 BACKGROUND

Monnom and Mobeybou are the two systems that underpin M&M. Monnom [8] is a digitally enhanced narrative environment that provides body-object interaction, employing various tracking systems and allowing easy integration of nearly any object into the virtual world. The whole installation consists of colourful objects, digital screen or projected surfaces, a bounded area where the children can play, a projection, a webcam for collecting data, and a computer with the Monnom software for data transmitting and transforming the interactive digital content. Through the webcam, its algorithm perceives objects with certain parameters of colour and depth analyses. It translates them into predefined digital patterns using various themes. In each theme, four patterns match four colours (red, yellow, blue, green). The online version [9] works on a computer, a tablet or a phone that has a webcam and is connected to the internet. By coming closer to the webcam or stepping back away from it, moving to the right and left in the physical environment all the while holding colourful objects, children can resize and replace patterns on the digital canvas. By moving around and adding objects to their physical space, children can fictionalise their meaning and create their own place(s) within the physical space with feedback from the digital environment. Mobeybou [19] Mobeybou is a storytelling environment composed of various tools. The central tool is the Mobeybou digital manipulative (DM), which uses physical blocks to manipulate the digital story elements. A total of 60 blocks represent story elements from eight world cultures. The blocks communicate with a computer device via Bluetooth and with each other via magnets embedded on the sides. Each cultural set comprises: a landscape, two protagonists, an animal, an antagonist, a musical instrument, and a magical object. Each block has the respective visual representation on the upper face. Connecting the blocks to the master block triggers its digital representation on the device's screen. When a block is removed it disappears from the screen. All the elements have specific animations that display different actions. Additionally, there are ambient and background sounds. The visual narratives unfold according to the combination of blocks that the users connect to each other while they verbalise their stories. The storyMaker is a digital representation of the DM that allows interaction without having the physical blocks. A set of interactive story apps completes the Mobeybou tools.

4 DEMO DESCRIPTION - INTEGRATED SYSTEM AND COLLABORATIVE NARRATION CREATION

The M&M system is developed as part of an ongoing research collaboration. Below we briefly describe the technical set-up and the algorithms.

4.1 Technical Infrastructure

The M&M system consists of sensors, software, and a screen. Figure 1 presents a diagram of the system's functioning. A range constrained camera technology, namely Microsoft Kinect equipped with custom-built software, serves as the sensor to capture the spontaneous movements of the child. This allows drawing parallels between the children's body movement in the physical space and its digital representation on the screen/ display, supporting children's active participation and imagination. The Kinect's microphone enables the children to use their voices to trigger atmospheric elements in the digital environment. We use the visual programming environment TouchDesigner due to its adaptable interface with Kinect and its easy integration with code written in Python. The data retrieved from the physical environment is processed, and then projected on the screen. The algorithm interprets body parts and their location in the space, removing the background. It also recognizes the sounds of the users and the objects with their colours. Different colours are matched with different digital narrative elements.

4.2 Interaction Rules

The M&M environment where the children engage in collaborative narration includes physical objects that children use to interact with the digital narrative elements. This scenario involves three phases of interaction whereby in each phase the interface moves further away from computer-based interaction towards more child-friendly, inherently collaborative, and spatial forms of interaction. These phases of interaction are: (a) the physical environment, where multiple input devices enable interaction, (b) the physical objects, where both physical and virtual objects are manipulated synchronously as part of the storytelling, and (c) the digital environment, where movement within physical space form the basis of interaction with the digital story elements. In the following, we illustrate the interactions between the story elements.

4.2.1 Narrative Landscapes and Atmospheric Elements. In the demo, landscape images with ambient sounds, representing different world locations and cultures, are used to provide children with multi-cultural themes as a stage for their narration. Three different themes are changed every two minutes, inviting children to explore hidden details in the images, and stimulating their imagination. We expect that different themes influence children's manipulation of their environment and their narrations, triggering different conversations between them. By looking at the digital canvas, the children may start to observe the theme image and plan how to reposition and move their avatars, (i.e., digital animated children's characters) through their bodily movements. Children can further compose the theme image, using colourful physical objects to trigger the digital magical objects.

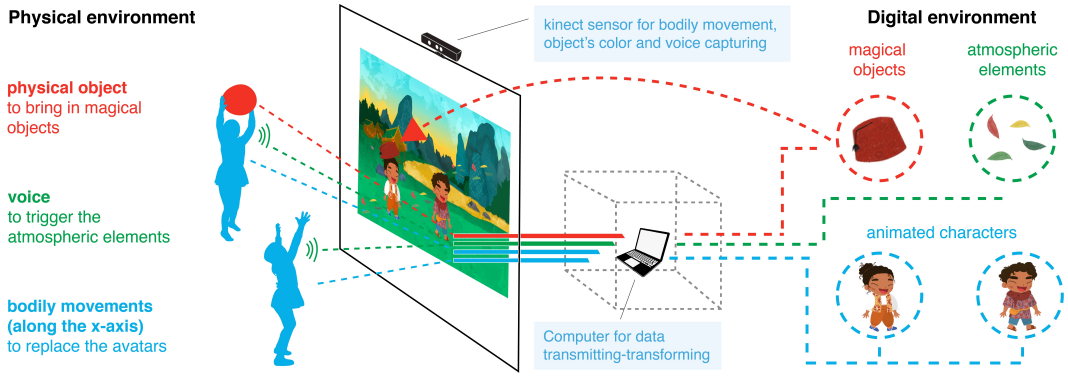

Figure 1: M&M System

The system also has atmospheric elements, such as "wind", which is triggered by the sound of the children. When the system recognizes the sound, the children become able to spread the leaves in the digital canvas with their bodily movements, while triggering the sound of the wind. This may transform children into narrators while inviting them to use their own voices to create the atmosphere.

4.2.2 Digital Playmates or Avatars. Children can control the location of the animated characters in the digital canvas by walking in the physical environment, by doing so, they become players that use their own bodies to reposition the virtual characters in the digital canvas. As such, children actively interact with their virtual playmates in narrations, which potentially fosters children's active participation in creative storytelling through role-playing. Simultaneously, children can observe their reflections on the digital canvas. Thus, acting both as story narrators and observers [20].

4.2.3 Magical Objects. The physical objects that are red in colour match with different story elements in the digital environment. While children use these objects and move with them in the physical environment, matched story elements appear in the digital canvas. Given that the system provides real time feedback, children can explore the effects of their movements and make plans for their next moves. This interaction scenario also provides children the opportunity to share physical objects and assign or take different roles [8]. This may develop children's metacommunication skills which are essential for children's play [2]. By supporting the visual construction of the story, M&M enhances children's opportunities to adapt to the space where the interactions take place. Building a scene needs children to imagine and design a story space, to position themselves as characters, and objects, and to create relationships among the story elements.

4.2.4 Seeds for Narration. In the system, the animals and the antagonists appear depending on different body-object combinations. When the sound level is above the threshold, the antagonists become bigger. By triggering a reflection on the composition of the scene, M&M may support the visual organisation of the narrative content.

In previous studies, we have observed that in such a scenario, children's play and narrative construction occurs in three levels, as children share the stage (controlling the characters, the physical objects, and the nature elements) and simultaneously perform with their bodies on this stage, while they also take the role of spectators, watching their own performances, that is the virtual reflection of their own physical movements [20]. The interaction with the digital environment through tangibles and movements provides children different interaction paths and helps them to acknowledge others' perspectives promoting negotiation and social interaction [8].

5 A PILOT USER STUDY - OBSERVATIONS ON CHILDREN'S NARRATIVE INTERACTIONS

In order to get feedback on the current prototype we carried out a small pilot study. The aim of the study was to inform future developments considering the children's dimensions and ways of using the system. M&M was tested in a room with three children (4-8 years old). The session began with a brief explanation of M&M by one of the researchers. Afterward, the researcher invited the children to explore and interact with the system. We observed diverse interaction paths and different roles. Once the play session started, two children (C1, C2) began to walk while observing their matched characters' movements. The third child (C3) observed the screen and his playmates moving with their digital playmates. After a while, he joined his playmates and began to walk through the room observing his own digital playmates. While they were moving, the children had an audible conversation about the characters that match with each of them. Then C1 picked up the red pillow and moved with it. The pillow triggered the representation of a magical hat. After this discovery she increased her physical activities, profusely jumping and walking. C2 explored the effects of the sounds on blowing the leaves in the digital canvas. After discovering this effect, his activity mainly focused on making a sound while moving. The children seemed to enjoy interacting with the system and although this was merely a small exploratory session carried out with the first version of the prototype, it provided valuable insights on how to improve the system. We realized that the interaction with the physical objects was not clear, and have now optimized the interaction algorithm. Further the position of the projection and the screen need to be adjustable so that it can be adapted to match children's height. Moreover, it is necessary to place the sensor on

top of the screen to perceive all children's movements and to avoid blocking the sensor. Despite these limitations, the session showed M&M's potential for engaging children and the robustness of the system.

6 DISCUSSION AND CONCLUSION

We have presented a scenario and a first prototype of an interactive narrative space that incorporates physical and digital environments. The present exploration is part of an ongoing research collaboration that aims at triggering children's imagination and bodily movements, providing meaningful and playful feedback during narration. The scope of the study was limited to the concepts of changing thematic backgrounds, sounds and to using simple physical object, that the users can virtually manipulate through physical movements. In future work, we plan to add more digital and aural elements as well as more physical objects in different colours. A limitation of M&M is that the system only allows for interaction with 3D graphics on a vertical 2D screen. Using multiple and different surfaces hold the potential to present immersive views to users. In future work, multiple Kinects can be used for inviting more users to use the system simultaneously. The live feed of physical acts on the screen may provide children with a rich and open-ended sensorial environment where children express themselves through multimodal forms of interaction and create narratives together. Also, the whole-body interaction may transform the children's surroundings into a theatre scene where children can move between different roles from player to narrator. In future work we will also investigate M&M potential to carry out pedagogical activities to understand its potential for learning.

SELECTION AND PARTICIPATION OF CHILDREN

The study protocol was approved by the Istanbul Technical University Ethics Committee. The parents of the three children participants consented in written form prior to the start of the study, and on the day of the study, the children assented to participate. The recordings from the study are stored on computers that are password protected and accessible only to the researchers on the approved protocol.

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