A Survey on Storytelling with Robots

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Abstract. This paper surveys some works on storytelling with robots. It tries to list type of robot used, who is the user of the system built, what is the focus of the study, and what is the outcome of the study. Most of the users are children, either normal or those with disabilities. The focus of the study includes robots as learning companions/pets, robot programming, interaction design techniques, technology introduction and pedagogy (robots as learning materials), and robots as teaching assistance. Meanwhile, the outcomes are a prototype, learning environment, authoring environment, and pedagogy experience.

Keywords: storytelling, robots, educational robot.

1 Introduction

Robots are engaging, motivating, encouraging imagination and innovation, and may improve literacy and creativity, especially for children. Children interest in robot may be due to its similarity doll and pet animals. Furthermore, it is argued that both male and female have the same interest but in different ways [1]. In [2, 3], educational robots are categorized into three types: learning materials, learning companions / pets, and teaching assistants. On the other hand, storytelling robots may be functioning as educational robots or not. The case of non educational robots can be seen, for example, in [4], the robot there played assistive task to meet therapeutic goals. D. Feil-Seifer & Mataric [5] lists assistive tasks, including: tutoring, physical therapy, daily life assistance, and emotional expression. In this case, the emotional expression task is highly related to storytelling.

Storytelling in general sense has been adopted by the human race to convey knowledge from generation to generation. Written in [6], "... storytelling has been a way to preserve culture and history, communicate ideas and feelings, and educate learners young and old." As new technologies found, they tend to be included in storytelling, storytelling with new technologies. The media may vary from the old one,

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pictures scarped in stones, to the new ones, such as digital media boosted with the Internet. In the case of robots, this may represent the extension of old storytelling habits with puppetry, traditional theater, dolls, or pets.

With robots, physical environment can be created instead of virtual environment. The advantage of physical environment is that many things and information can be sensed "via our sight, hearing, olfaction, palate and tactus" [7]. On the contrary, virtual environment also has its own advantages: it is less dangerous; it can be much less expensive; and it is possible to enter inaccessible places [8].

This paper surveys robot storytelling. The papers collected were mostly from Google Scholar search by using keywords 'allintitle: storytelling robot,' that is, papers having words in its title, 'robot' and 'storytelling'. Simple discussion is based on users, focus of the study, and outcome.

2 Categorization

This section is divided into four sub-sections on types of robot/machine used, users, focus of the study, and outcome.

2.1 Types of Robot/Machine Used

Table 1 shows a list of studies and respective robot/machine used in the study. Worth noting is the work in [9] in which a simple robot very similar to an inexpensive radio-controlled toy car was used in creating a mobile mixed reality environment using a system called GENTORO.

Table 1. Robot/machine type used in storytelling with robot

Type	Paper
Handyboard	[6] [10]
LEGO Mindstorms kit	[11]
Custom made	[4] [12]
Robosapien V2	[13]
PaPeRo (NEC Corp)	[14]
LEGO Mindstorms kit	[15]
Pleo	[16]
(a simple robot)	[9] [17]

2.2 Users

Children. PETS [6] is designed for elementary-school-age children. Animal form of robot is chosen because of children interest in animal to ignite imagination and curiosity. Children are especially interested in things and activity with physical involvement. Besides, storytelling is also a part of a childhood ingredient in that children tend to do a storytelling on their own. In this system, children can create a robotic pet by

assembling its parts, create a story with robot emotions and behavior throughout it. The machine behind the robot was Handyboard.

Also targeting at elementary school children [13], a robot was made to become programmable by the children to do a storytelling task. The children can teach the robot to tell stories by first writing English stories supported by story guideline and picture cue via a story write interface. The children then speak each sentence in the story for the robot to learn.

In another work, children were facilitated in their storytelling with tangible props by combining physical and digital authoring environment [16]. The system also supported variation in children performance style between verbalizers (those who talk more and draw less) and visualizers (those who draw more but talk less) and applied a pluralistic programming approach to easily control and program Pleo's behavior. Meanwhile, in [17], a mobile environment and tool, called GENTORO, also for children storytelling was made. The mobility was made possible due to the use of a handheld projector to create a scene on a horizontal area.

Disabled Children. Also targeting at children but those with disabilities, C. Plaisant et al. [4] described the development of a prototype storytelling robot "to motivate the children and help them reach their therapy goals through therapeutic play." Storytelling ingredient was included to provide long term motivation in doing therapy exercise. Therapy goals may be reached for physically challenged children through muscles or for development disabled children through joints exercising or story reflection [12].

Similarly, targeting at children with intellectual disabilities and/or autism, a new learning environment with a prototype personal robot PaPeRo from NEC Corp as its major part was created to enhance children's storytelling tasks and to assist them in producing email text [14]. The robot was involved in a classroom interaction. It can recognize each student via student's ID tag.

Adult (Teachers) and Children. In [11], teachers and students in four Irish primary schools as part of "Empowering Minds" collaborative project between MIT Media Lab, St. Patrick'c College, and the primary school teachers were involved in a framework to develop technological fluency and to use technology within the schools. The teachers without previous experience with Mindstorms were recruited in a workshop to gain design experience that can be transferred to their students.

Similar with the above study but with the context of Portuguese elementary school education, a qualitative case study with two robotics projects was carried out in 4th and 6th grade [15]. The children did robot construction and programming aiming at dramatization of a story and doing storytelling projects: fashion show and dance choreography. In this study, teachers were not explicitly mentioned as the target of the study, though of course they were involved during the learning process.

2.3 Focus of Study

Robots as Learning Companions/Pets, Robot Programming. Using custom interfaces designed for the children to interact with, the robot was designed to accompany the children to be taught in doing a storytelling [13]. The robot can be programmed to tell a story enhanced with movements, background music, and sound effect. This way,

children interest in learning English may be triggered by more practice in speaking and their worry in oral task may decrease.

In [16], Pleo robot interacted with children via enhanced children drawings in cards and the robot can be programmed to behave accordingly via the GUI interface. The children also can touch part of Pleo as another method of interaction. They played with Pleo while programming, adding audio narration, and creating a story. Thus, physical environment was created for children to easily play with, combined with a digital authoring environment. With a different approach, simple robot path instruction by children was provided in story rendering part in which children can draw the robot path [17]. In this work, no story design tool was provided because the focus was on story rendering and expression.

Design Techniques. PETS [6] stressed on design experience in a mixed-age design team between adult and children. Although it relates the product with educational applications, during the process, it applies cooperative inquiry and iterative prototyping design techniques. Lesson learned from this, ignited the creation of a more specialized prototype for disabled children with specific user scenarios [4].

Technology Introduction and Pedagogy (Robots as Learning Materials). In [11], robot technology was introduced first to teachers and later from the teachers to their students. Using project-based learning to reveal how children learn a technological concept. Narrative was used to scaffold the work of the children. Technical and pedagogical issues were revealed from the activities in projects for the possibility to pedagogical change.

Another successful educational robot study was similarly implemented with storytelling projects [15]. In this project, three steps were applied: study preparation introducing the basics of LEGO Mindstorms platform, storytelling project development, and final result presentation to the community.

Robot as Teaching Assistance. Robot as teaching assistance differs in robot as learning companion in its main user. In the case of teaching assistance, the users are teachers, whereas in learning companion the users are students [18]. In [14], a robot was used in classroom-based language learning with a more child-friendly interface that can do human-like communication, with environment structure fitted to children with disabilities. The learning environment was structured so a personal robot supported teaching/learning activities in regular language lessons.

2.4 Outcome

Design Experience. Design experience gained in PETS [6] includes some guiding principles on how to cooperate between adult and children about new power structures, similarity in voice that is completely different from children's school culture, and requirement to create a convenient design environment.

Pedagogic Experience. In [11], three out of eight classroom projects were explained. Different stories were given for each project to scaffold the project creation using LEGO Mindstorms materials. Primary school students were introduced with these

materials. It was proven that the children could understand and apply complex design under the supervision of already trained teachers. Storytelling (narrative) was used as a scaffold in building the projects.

In [15], children could build and program the robots for specific tasks. A pedagogical context to new technologies was provided by integrating much information available. In this case, critical and logical thinking was built, while interaction and autonomy as well as interest and motivation for learning were increased.

Prototype. Those stressing with design techniques and user interaction [4], [6], [10], prototypes were produced, and in future work, robot toolkit consisting of a base robot and accessories may be produced.

Authoring Environment. A storytelling authoring (programming) environment for children to be performed a robot [13] was built in GUI fashion. The facility was aimed at motivating the children in learning English as a second language. As children create the story, teach, and speak it to the robot, they learn speaking skill. They do not need to feel shy or funny because their partner is just a robot. Like animals, for the children, robot is viewed as a non-threatening and non-judgmental creature [19].

More than using GUI, a mixed physical and digital authoring environment was produced in [16]. The environment can be used by the children to create their stories using enhanced drawings interacted with GUI to manipulate Pleo robotic characters. The manipulation can also be done by using physical touch, thus resulting in multimodal tools to make creative storytelling.

Learning Environment. A personal robot from NEC corp, PaPeRo, in a new learning environment, was used in front of a class with teacher-led activities to encourage students with intellectual disabilities and/or autism to tell more stories [14]. It was shown that there was a constant increase in story length and story grammatical complexity the children produced.

Mixed Environment. A system, called GENTORO, using a robot and a handheld projector was designed to create a mixed environment integrating physical and virtual spaces [17]. It can help children in storytelling, both design and expression of creative and original stories. The robot played as the character of the story, permitting children embodied participation due to mobile nature of the handheld projector and the robot. The system built enables the children to make a robot perform their created story in a physical area [9]. The environment thus created is a mobile mixed reality environment.

3 Final Remarks

Users of storytelling robots mostly are children. Children learning, in Papert's opinion, should be constructionistic rather than instructionistic. "In the constructionist approach, students learn from designing and assembling their own robots" [2]. Another type of users is children with disabilities. With this type of users, the system designed should play therapeutic and restoration functions.

Works with the title containing the word 'storytelling' and 'robot' are still few. This may indicate that researches in this area are still promising and need to be done. The possibility of mixing among storytelling, children, and a robot vary as follows: a robot is given a storytelling feature to perform before the children; children are permitted to do programming and story designing for the robot to perform; a robot is designed to motivate children to do storytelling; children are facilitated to assemble a robot character and its environment and they create a story for the robot to act on; a robot is programmed by a teacher to perform teaching assistantship (including storytelling), for example, in a language learning class; and so on. Complexity may be increased by adding more than one robot character. The application context variations among others may include: interaction design experience, education and learning, assistive function, pedagogy, instructional design, and learning environment.

Besides, the robots give a physical touch in a physical environment. Combined with a virtual environment, a storytelling robot becomes an immersive environment for children to express their story [17]; therefore, a mixed reality environment is created. This environment is what we call as the Digital Learning Playground (DLP) currently we have been working with [20].

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