Robot Assisted Reading: A Preliminary Study on the Robotic Storytelling Service to Children in the Library

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Abstract. It is important for the modern library to cultivate the public's information literacy and reading literacy. When these two important tasks can be rooted in the children's readers, the function of the library can be even more meaningful and demanded. Therefore, all public libraries try their best to attract more children to come to the library, and naturally parents come together with children to enjoy reading in the library. Because children have only limited vocabulary ability, reading plain written books is very difficult for them and it is not even effective. As a result, various digital children's readings have been developed over the years, such as pictures (picture books), audio (CD audio books), and video (multimedia e-books). However, the interaction between these materials and children is limited to 2D flat touches, such as texts, pictures, and audios/videos. Children would not feel touched and interactive when listening to the stories read by adults who have no training for reading aloud skills. Therefore, this study intends to combine the robot with the existing digital picture books of the library to complete a "robotic storytelling service for children." In this study, we designed a scenario that combined a digital picture book with added robot voices and body postures/movements that match the mood of stories. This allows the robot to tell a story and perform a story like a human being with body movements to attract children's interest and attention. And the robot can also draw the children's attention to the story and increase the listening effects. This service has received a very enthusiastic response from the children readers. It also enabled the children to be close to the robots and listened to the robots to tell stories for them in a very focused and exciting manner. Furthermore, they seem to be motivated to go to the library to find the corresponding story books to read. Therefore, robotic storytelling approach may have a potential to promote children's reading interests and can be widely implemented in the future.

Keywords: Robot assisted reading · Robotic storytelling service
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1 Introduction

What many people may miss so much in their lives is that parents read story books for them during their childhood because it can be really warm, enjoyable, and memorable. Such experience also greatly influences whether children can get close to books in the future, be willing to read, be able to read for their life, and even achieve the ideal state of a scholarly society. This is why many countries aim at promoting literacy for the preliminary and primary education.

In a society, the library has the functions of education, information provision, culture, and leisure. It is also dedicated to playing the life and knowledge center. Moreover, with the development of science and technology and the great changes made by the advent of the digital era, the means of disseminating knowledge is no longer only via papers, but e-books, e-journals, electronic databases, and digital audio and video resources. The digitization of science and technology has caused changes in people's reading behaviors, affecting the ways reading materials can be presented, and transforming the original library services.

With the booming development of information technology and the growing maturity of digital communication applications, there is also a trend to upgrade from a digital library to an intelligent one [1]. Therefore, libraries are currently actively researching robot-related applications [2]. They hope to introduce robot services into libraries and use robots to attract more people to come to libraries or make people enjoy reading.

In addition, since reading is a basic function of the libraries, it is facing the challenge of digitalization. In recent years, in response to the advent of the digital age, libraries have purchased diversified electronic resources especially for the needs of children's picture books. Generally, there are three types of the database for children's electronic picture books: procurement, collecting public resources, and self-built sharing. Among them, self-built sharing is made by National Library of Public Information (NLPI), Taiwan assets. Since 2011, a "Digital Collection Project for Students Created Picture Books" funded by NLPI has been established. The content of picture books was created by students. And then, NLPI selected the qualified vendors to carry out the digital works on the electronic picture books and then formed the "collection" and "circulation" of a "Picture Book Database (PBD) [3]". Although it is an original resource consisting of different students' works, the library has maintained the copyright of the created online reading/picture books for the public. The purpose of PBD mainly aims at making students' dreams come true when they create their own picture books!" [4].

This article will first introduce the NLPI service of humanoid robot storytelling for children by using the stories of children's picture books in the PBD. It further describes the creativity and imagination of the robot engineers to form robots' various performances and functions depending on the users' requirements. So far, we have decided to select a humanoid robot, NAO [5] because of its human-like appearance, behavioral actions, thinking, and emotional expressions. Moreover, this article will depict how to design a humanoid robot program to perform audio storytelling in conjunction with body movements and expressions, so that it will be easier to attract readers' attention and affection.

2 The Design Process of Robotic Storytelling Using an NAO Robot

In the robot storytelling service, the robot is not only a system platform showing the content of the story, but its more important role is to tell a story that can attract children. This section will refer to the process of how to design the robot storytelling service.

Step 1: Selecting the story and get its voice file (.mp3)

As indicated, the story source of the e-book is from the PBD of NLPI. A target story would have the features of interesting and emotional content from the database. Since a story will be told by a robot, the story selection is based on the style of the storyteller as the first person. In this way, the robot can express actions and sounds in the way of the first person. That is, a robot is talking about its own experience/story, so that the story can be more direct, vivid and real.

Step 2: Matching the segmented voice files with the story content and time sequence

The idea of robotic storytelling service is that the robot's action can associate with the meaning of the children's story. It can be achieved by adding a human body gesture or movement that is consistent with the meaning or symbolic expression of a specific storyline. The human body gesture or movement is then designed as an robotic action. Afterwards, voice files are fit into each storylines. This study uses the e-book "A talking hole" as an example for the robotic to tell this story (see Fig. 1).

Step 3: Designing body gestures/movements that meet the storyline

A robot motion designer must firstly listen to a story in order to understand this story. Then, he or she will design a body movement either matching the story or focusing on certain keywords in the plot. For example, the protagonist, Dongdong, has an "exhaustively pondering about …" statement in the "A talking hole 005.mp3". A robot motion designer may design a matching movement in which a robot repeatedly grabs its head by its hand several times so that the listeners can easily associate and figure out the story situation- "thinking over again and again" (see Fig. 2).

Step 4: Combining the story's voice files and matching robot's body movements

In this step, the designer will use Choregraphe [6], an NAO robot application development tool, to combine its body movements with the voice files of the story. Choregraphe can help designers to edit NAO's actions and behaviors that are linked together with events and time sequence. The timeline is used to express the time sequence accordingly. NAO's body movements can be edited to be the multimedia data, such as voice files, text-to-speech files, etc. can match with the movements. Through the management of timing and triggering, NAO's events, actions, behaviors, and voice files can be activated to allow NAO to have conversations with users. As a result, this allows robots to tell stories with interesting effects of actions.

Sequence of story paragraphs	Segmented voice file	The text of each storyline
1	A talking hole 001.mp3	"A talking hole"
2	A talking hole 002.mp3	"A cub, Dongdong, is very annoying."
3	A talking hole 003.mp3	"Because the Lion King makes an order"
4	A talking hole 004.mp3	"all the animals have to write their own dream cards."
5	A talking hole 005.mp3	"Dongdong exhaustively thinks about that, but he does not know what to write on his own dream card."
6	A talking hole 006.mp3	"It's the best job to be a doctor because you can make much money."
7	A talking hole 007.mp3	"A tiger Pangpang said that in a very confident manner."
8	A talking hole 008.mp3	"However, Dongdong does not want to make much money."
9	A talking hole 009.mp3	"A rabbit Meimei said:"
10	A talking hole 010.mp3	"being a pianist is the best dream,"
11	A talking hole 011.mp3	"so that you can look beautiful."
…	…	…

Fig. 1. Example of segmented voice files from an original e-book

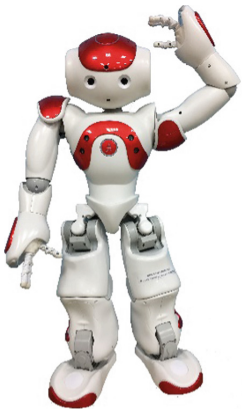

Fig. 2. NAO repeatedly grabs its head by its hand to express "exhaustively thinking"

3 Results and Discussions

As aforementioned, a robotic storytelling service has been implemented and opened to the NLPI readers, so there was a need to explore the degree of reader acceptance for this service by using a questionnaire investigation.

There were 52 children (31 boys and 21 girls) from an Elementary School nearby the library in Taichung City. They were first invited to come to NLPI to get involved in the robotic storytelling service. Then, they were guided to answer the questionnaire.

The experimental process is as follows:

1. The moderator made a welcome speech and gave a brief introduction to the robot NAO.
2. NAO introduced itself.
3. NAO began to tell stories with the story slides behind it (the two stories were: "A Talking Hole!" 4 min and 26 s, "Pippi Adventure" 2 min and 57 s). Instead of using an overhead projector, a large-sized (55 inches) computer screen is used behind Nao to show an e-book story in order to make it easier for listeners to get involved in the visual background of the story.
4. After the two stories had been heard, the children were grouped with five people each. The assistant researchers helped the children to complete the questionnaire by verbally reading the questionnaire.
5. Before leaving the robotic storytelling room, children were awarded to watch NAO dancing for 3 min and 30 s. By observation, they were so excited and left the room happily

It can be seen from the records that many children were so engaged and very focused during the robot's storytelling time. From time to time, their facial expressions changed.

After the robotic story time was over, a questionnaire was used to collect children's opinions of the robot's storytelling. The Likert scale 1 to 5 was designed to indicate the level of their preferences. As the children were little, the assistant researchers had to explain the meaning of the topic to the students so that this could increase and assure their understanding of the questionnaire items.

The basic information was obtained from Part A. The two classes have similar proportions of gender and age. They are students of about 7 to 9 years of age and live in the school district around NLPI, i.e. in the southern district of Taichung City. The result shows that the majority of these children had never or rarely visited this library (nearly 68%) before this robotic storytelling experience.

This can be compared with the follow-up question "Have you ever come to NLPI Children Learning Center to listen to stories?" The answer to "No" (80%) was much more than the one of to "Yes" (20%).

The data analysis for the part B of the questionnaire was analyzed by SPSS statistical software. The reliability level reached a high confidence of 0.898. Table 1 shows the means and standard deviations of the 9 questions.

Similar to what the researchers observed during the robot's presence, all items have the average score at least 4 points. Regarding Question 8, when children were asked if

Table 1. Statistical results of Part B of the questionnaire

	Average	SD
Part I. The system acceptance Q1. I can see the movement of the robot clearly	4.49	1.023
Q2. I can hear what the robot talked clearly	4.78	0.685
Part II. Content acceptance Q3. I like the story that robots told	4.59	0.840
Q4. I agree that robot gestures/moves in the storytelling are very appealing	4.53	0.793
Part III. Learning Pace Q5. I agree that the speed of the robot's storytelling is just right	4.65	0.830
Part IV. Comparison with traditional law Q6. I agree that robots are more attractive than listening to the audio materials	4.51	0.938
Part V. Motivation improvement Q7. After listening to the robotic storytelling, I am willing to read this story book	4.08	1.336
Part VI. Future promotion Q8. I would like to hear robots telling stories next time	4.80	0.577
Q9. I would like to have my friends to listen to robots to tell stories	4.39	1.239

they would like to hear robots telling stories next time", their agreement was the highest among all. In addition, reading the result of Question 6 to know if they agree that robots are more attractive than other audio storytelling materials, we can see a high score of 4.51, indicating that children feel that robots' three-dimensional, real, and touchable may be more interesting when comparing to the monotonous flat audiobook story CD (auditory only). So the interaction between humans and robots can be applied to teaching because this will not only improve teaching efficiency but also increase learning motivation. This also echoes the study of a scholar [7]: if the learning process can make students feel less anxious and happy, it can effectively improve students' learning motivation and teacher's teaching effectiveness. Obviously, this service is consistently and eagerly anticipated by these children.

However, the lowest mean score and the highest standard deviation was found in Question 7, "After listening to the robot storytelling, I am willing to find out this story book". Perhaps partly because these children were not interested in this particular story, or children usually do not often read or borrow books in the library. Thus, the future study may have to consider the selection of the story, such as action story for the robot to make more interesting actions. Moreover, some children's favorite background music may be used to attract the attention of children.

In addition, this study further explored the difference between male and female students' preference and acceptance of robot storytelling by the analysis of a single sample t-test. Surprisingly, most people may have a stereotype that boys' acceptability and preference of robots should be higher than that of girls. However, from Table 2, it can be found that girls' preference for robot storytelling is even higher. The average number of opinions on each issue is higher than that of boys, and the analysis of

standard deviations shows that the views of girls are more consistent. At the same time, from the analysis of the Q7 and Q9 questions, we can find that compared with boys, girls have a more positive attitude towards the use of robot storytelling services. Furthermore, from the p-value result, it can be found that the gender factor is indeed a significant and important difference factor for the robot storytelling service ($p < 0.05$, as indicated by the p-value in Table 2 '*'mark). Except Q2 and Q8, the p values of other questionnaires are less than 0.05. In terms of Q7, girls are more likely to use library resources to find out and understand the original content of the story. The results can be provided to the library if they wish to attract children readers to use robot-related services.

Table 2. Differences in opinion of the questionnaire between boys and girls

	Gender	Average	SD	p value
Part I. The system acceptance Q1. I can see the movement of the robot clearly	Boy	4.21	1.236	0.007*
	Girl	4.90	0.308	
Q2. I can hear what the robot talked clearly	Boy	4.66	0.857	0.086
	Girl	4.95	0.224	
Part II. Content acceptance Q3. I like the story that robots told	Boy	4.38	1.015	0.014*
	Girl	4.90	0.308	
Q4. I agree that robot gestures/moves in the storytelling are very appealing	Boy	4.34	0.897	0.030*
	Girl	4.80	0.523	
Part III. Learning Pace Q5. I agree that the speed of the robot's storytelling is just right	Boy	4.48	1.022	0.046*
	Girl	4.90	0.308	
Part IV. Comparison with traditional law Q6. I agree that robots are more attractive than listening to the audio materials	Boy	4.31	1.105	0.044*
	Girl	4.80	0.523	
Part V. Motivation improvement Q7. After listening to the robotic storytelling, I am willing to read this story book	Boy	3.66	1.542	0.002*
	Girl	4.70	0.571	
Part VI. Future promotion Q8. I would like to hear robots telling stories next time	Boy	4.69	0.712	0.074
	Girl	4.95	0.224	
Q9. I would like to have my friends to listen to robots to tell stories	Boy	4.07	1.510	0.012*
	Girl	4.85	0.366	

4 Conclusions and Future Studies

As the development and application technologies of robots become more and more mature, the development of "humanity" for humanoid robots will become more and more real. The focus of this research is to share experience in narrating services for children with NAO robots. The preliminary results have already received a very enthusiastic response from children's readers.

Although the robot storytelling service for children was proved to be greatly welcomed by children in this study, the main difficulty in practicing this type of service is not the technical problem of robot programming but the issue of how the robot can do more interesting but not simple performances. The robot's gestures and motions may need to combine with sound and light, as well as the artistic design on the stage or platform. Therefore, the robot performance designer is likely to be a very important market-based emerging work and talent demand areas in the future when the governments in different countries vigorously develop robot applications.

Looking ahead, it may be worthwhile pondering whether the use of robots can lead and accompany these children to enhance their reading habits and long-term interest in reading, and even to enhance reading concentration. In addition to the storytelling performed by NAO humanoid robots in this study, more different types of robots can be used in the future. For example, a Pepper robot with a human appearance but a larger body and a tablet capable of displaying information. The Zenbo robot, as well as being cute and compact, has a tablet that can show the expression and slide, to develop more intelligent robotic services for library users. In the future, the library-provided robot services may need to know how such a technology can let readers enjoy various functions and tasks.

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References

1. Ouyang, H.J.: Sharing the experience of planning picture book databases. Taiwan Public Libr. J. **5**, 5-1–5-14 (2017)
2. Tsai, M.-F., Lin, J.-M., Shen, W.W., Lai, C.-C.: Exploring the feasibility of applying robots to library services. Nat. Central Libr. Bull. **1**, 153–180 (2017)
3. Picture Book Database. http://storybook.nlpi.edu.tw/. Accessed 31 May 2018
4. Lan, M.-K., Jhang, W.-J.: The service of picture books in public library: a case of the picture book database. Public Libr. J. **3**, 1–21 (2016)
5. Product introduction to Robot NAO. http://www.nao.com.tw/product. Accessed 18 Dec 2017
6. Choregraphe. http://ii.tudelft.nl/naodoc/site_ch/greendoc/choregraphe/choregraphe.html. Accessed 5 Feb 2018
7. Papert, S.: Mindstorms: Children, Computers, and Powerful Ideas, 2nd edn. Basic Books, New York (1993)
8. Tsai, M.-F., Shen, W.W., Lin, J.-M., Lai, C.-C., Syu, Y.J., Lin, S.T.: Applying humanity robot to the storytelling service for children in a library–a case study on national library of public information. Taiwan Public Libr. J. **7**, 1–33 (2018)