IFLA WLIC 2019 Athens

Submitted on: 11.09.2019

Information Technology *Satellite Meeting*
"Robots in libraries: challenge or opportunity?"
21-22 August 2019
Technical University of Applied Sciences Wildau, Berlin, Germany

Robotics and artificial intelligence technology in Japanese libraries

Takashi Harada
Center for License and Qualifications, Doshisha University, Kyoto, Japan.
E-mail address: ushi@slis.doshisha.ac.jp

Abstract:

Robotics and artificial intelligence technology are rapidly spreading in libraries. Conventionally, libraries have used an auto book circulation system or automated storage and retrieval system (ASRS) both with automatic control technology. In recent years, robots have been used in various other places in Japanese libraries. A guiding humanoid robot is a typical example. The humanoid robot Pepper developed by Softbank is already active in dozens of libraries, and there are plans to introduce 500 or more. As a guiding robot, animal type robots such as a rabbit are also used.

In addition, there are many robots that work behind the scenes in libraries. For example, an auto-tracking booktrack makes it possible for a librarian to perform return processing without having to operate a heavy booktrack. The robot suit HAL (Hybrid Assistive Limb), which was developed at the University of Tsukuba, assists lifting work and reduces the burden on the waist. The Tsukuba Central Library uses HAL to lift heavy bookcases onto a bookmobile.

Furthermore, artificial intelligence technology is being used for reading assistance and programming classes in libraries. The game "KOKORO" Saver, which we developed, has a mechanism to recommend children's books according to their interests. Kindai University library analyzes the content posted on social networking sites (SNSs) and introduces books that match the potential interests of the student. Although the use of robots in the library is still developing, it is expected that robots will be used more and more in the library.

Keywords: Robotics, Artificial Intelligence Technology, Japanese library, Pepper

1. Introduction

It is difficult to define clearly the word "robot" because it is often used in various ways. For example, it can be expressed as "a device that works on behalf of a human, which automatically and continuously performs some steps or procedures". Robots can be classified as follows in terms of roles, missions, and forms.

(1) Industrial Robots
A robot that performs autonomous work automatically on behalf of humans in production work in the industrial field.
(2) Working in a Hazardous Environment
A robot that works autonomously in situations where people cannot work, such as accident sites.
(3) Daily Life Support
A robot that provides a human support function in human society. For example, robots that play a role such as housework support and nursing care support in daily life (service robot) or robots that imitate the form and movements of humans or animals (amusement robots).

2. Use of Robots for Public Service of Library

In the library, it is assumed that some kind of humanoid robots will be used to support daily life in terms of public service. Industrial robots will also be used for technical service in the library. Even in Japan, the introduction of various robots has begun gradually. Some robots are installed permanently, and others are worked for limited periods or for events. The following is an example of the introduction of robots in Japanese libraries.

2.1 Library Guide by using Semi Humanoid Robot "Pepper"

"Pepper" is a semi humanoid robot developed and sold by Softbank Robotics. There are three models available: a home model ("Pepper for Home"), a corporate model ("Pepper for Biz"), and a school (education) model. The main features of "Pepper" are as follows.

(1) About 120 cm in height, about 29 kg in weight, and a battery operating time of about 12 h.
(2) Various sensors in the head, chest, hands, and legs.
(3) Equipped with a camera and a microphone.
(4) Equipped with a tablet-type touch display on the chest.
(5) It moves with a wheel called the omni wheel, which can rotate freely. It is not a two-legged robot.

For example, "Pepper" has been working in The YAMANAKA Public Library for the People's Creativity since 2015, the Fukuoka City Public Library from 2016 to 2018, and the Kitami Institute of Technology Library since 2017. Several "Peppers" have been introduced to the Yamato City Library, which was opened in 2016. In addition, the company TRC Library Service Inc., which is entrusted with the management of the libraries of more than 500 local governments in Japan, introduced "Pepper" in 5 libraries in the Tokyo area.

Most "Peppers" working in Japanese libraries are the corporate model, "Pepper for Biz", but only the YAMANAKA Public Library for the People's Creativity has purchased one of the first batch of 1000 "Peppers" which is a prototype of the "Pepper for Home". "Pepper for Home" is superior in its emotion engine, cloud AI (learning by data accumulation), chat function, and so on. On the other hand, "Pepper for Biz" has features that introduce application software for businesses easily and enable an interaction analysis.

"Pepper" in libraries is mainly used for displaying library guidance or tourist information on the tablet on its chest, with some exceptions. At the moment, there are not many mechanisms for library-specific tasks such as a collection search and reference service.

As a unique attempt, the YAMANAKA Public Library for the People's Creativity makes its actively communicate to users using the home model's rich emotional expression. In addition, a workshop called the "YAMANAKA Pepper Development Plan" was held in which users further developed "Pepper" and its applications. As a result, in the YAMANAKA Public Library for the People's Creativity, there was a highly positive effect on promoting the use of the library. For example, users often talk to "Pepper" freely or act with the assistance of "Pepper"[1].

Fig.1 Pepper in YAMANAKA Public Library for the People's Creativity[2]

Furthermore, in Edogawa City Library Shinozaki Library, where "Pepper" was first introduced in libraries managed by TRC Library Service Inc. in 2016, "Pepper" is in charge of the "question answering service", "support for collection search", and "acceptance of seat reservation system" in addition to library and local area guidance. Among these responsibilities, regarding the "question answering service", "Pepper" answers frequently asked questions in the library by using the Q&A automatic response service "TalkQA" collaborated with IBM's question-answering computer system "Watson". By gathering about 1,500 words that are frequently used in libraries and creating a conversation database, "Pepper" answers simple questions such as "Where is the bathroom?". In addition, the "support for collection search" is displayed by scraping the search results of WebOPAC. Furthermore, the "acceptance of seat reservation system" is a function to reserve a seat for reading materials by reading a user card using "Pepper's" reading function. Although these functions are not applicable to all libraries, TRC plans to expand the use of "Pepper" to more than 500 libraries in Japan in accordance with their needs[3].

Fig.2 Pepper in the Edogawa City Library Shinozaki Library

It is also being considered to use “Pepper” as an input device for various automation devices. Although it is not a system in use, a method of talking to “Pepper” for inputting an automated bookshelf was presented at an exhibition by BUNSHODO CORPORATION and Headwaters Co., Ltd. in 2015. Visitors of the exhibition enjoyed the convenience of being able to take out the target book by talking to “Pepper” and following “Pepper’s” comical movements[4].

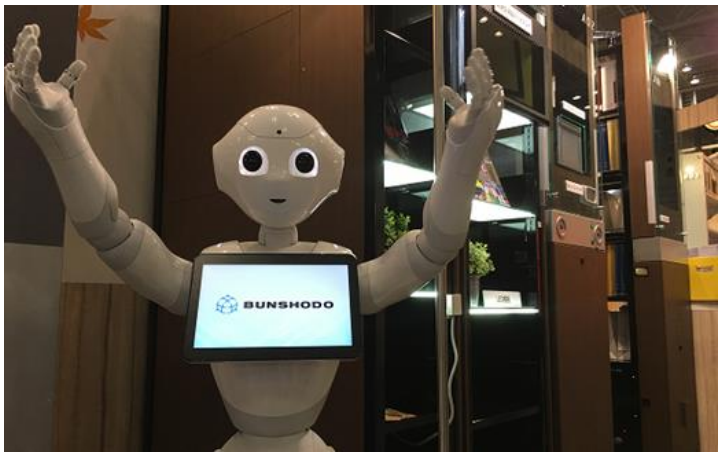

Fig.3 Pepper as an input device for automated bookshelf
that is demonstrated in Library Fair in Japan 2015[4]

2.2 Library Information Display Robots Other Than “Pepper”

Guidance robots are being developed besides Pepper - for example, the animal type guidance robot “Koro”(Fig.4), developed by Masahiro Tanaka and others, although they are still at the research and development stage. “Koro” was originally developed as a mobile robot. It was installed near the entrance of the library of Konan University in 2016 and is sometimes operated as a guidance robot that can project the result of a conversation with users on the display installed on the side of it. “Koro” can talk with people based on the movement of the user’s finger using a sensor such as Leap Motion. “Koro” can also display various videos of floor maps and library usage guidance. In addition, a function to talk with library staff in another room in response to the user’s call is also implemented[5].

Fig.4 "Koro" in the Konan university library

In addition, the Library of the University of Electro-Communications has introduced interactive robot by Vstone Co.Ltd., “Sota”, which provides questions and answers about how to use the library, how to learn, and how to search for materials according to each situation[6].

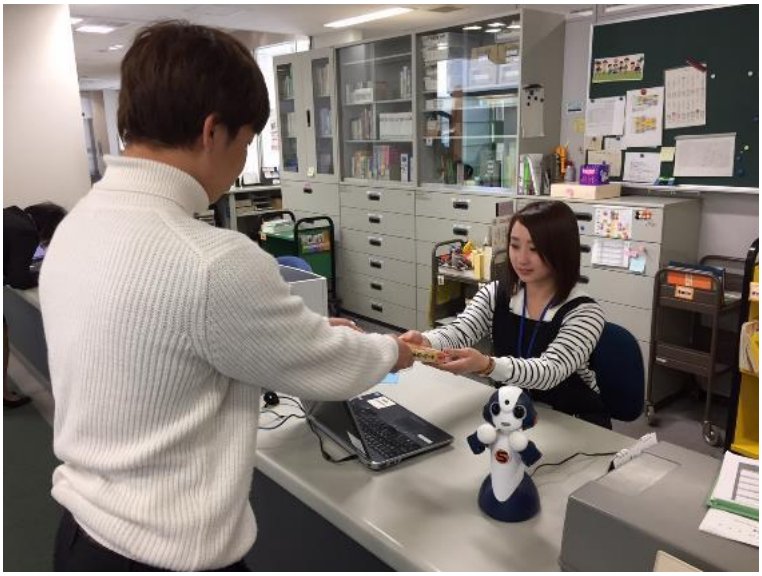

Fig.5 “Sota” in the Library of the University of Electro-Communications[6]

2.3 Humanoid Type Help Desk Support Robot

Konan University also provides a reference service in which the robot “An-San”, which looks like a human, is installed at the counter of the library. “An-San” was originally developed by Dr. Tomohiro Umetani, who is an associate professor of the Faculty of Intelligence and Informatics, Konan University, in order to study tactile sensations of human fingers. Library staff at a remote place can talk with visitors through “An-San” by combining a camera and a microphone. At the moment, “An-San” does not have a function to generate automatic answers to questions, but the reputation of the system from users is high, because “An-San” is a stable

and practical system, and the operability of remote control is extremely high. In addition, in this system, a mechanism that can create difficult reference records at the time of help desk correspondence is also implemented using speech recognition technology. By using “An-San”, it is also expected that basic data for a future automatic reference system will be collected.

Fig.6 "An-San" in Konan university library

2.4 Guidance to the Bookshelf by the Leading Robot

A robot that guides the user to a bookshelf is currently installed. A rabbit-type library guidance robot “Uta-San”, developed mainly by Dr. Takashi Kawamura, who belongs to the Department of Mechanical Engineering, National Institute of Technology (KOSEN), Oyama College, has functions to read reflected light from reflective tape laid on the floor and to travel along it. “Usa-tan” stops in front of the prespecified bookshelf. The purpose of the development is to have students in the elementary school lower grades feel closer to the library and read more books. It was reported that the motivation to go to the library of the children using “Usa-tan” increased in the proof experiment conducted at Oyama City Central Library[7].

Fig.7 "Usa-tan" in Oyama City Central Library[8]

2.5 Biblio Battle by Robots

Biblio Battle is a reading society in the form of a game that originated in Japan in which several book introducers introduce their favorite books in front of an audience and conduct discussions by all participants. After all the presentations are over, a vote is made on the basis of "which book I would like to read the most" to determine the book that collected the most votes.

In the Biblio Battle held at the Yukuhashi Public Library in 2018, instead of humans introducing books, programming for the 58-cm tall humanoid robot "NAO" was carried out, and an event in which "NAO" introduced books by using gestures was held. It can be said that this was a unique attempt to combine robot movements with book introductions[9].

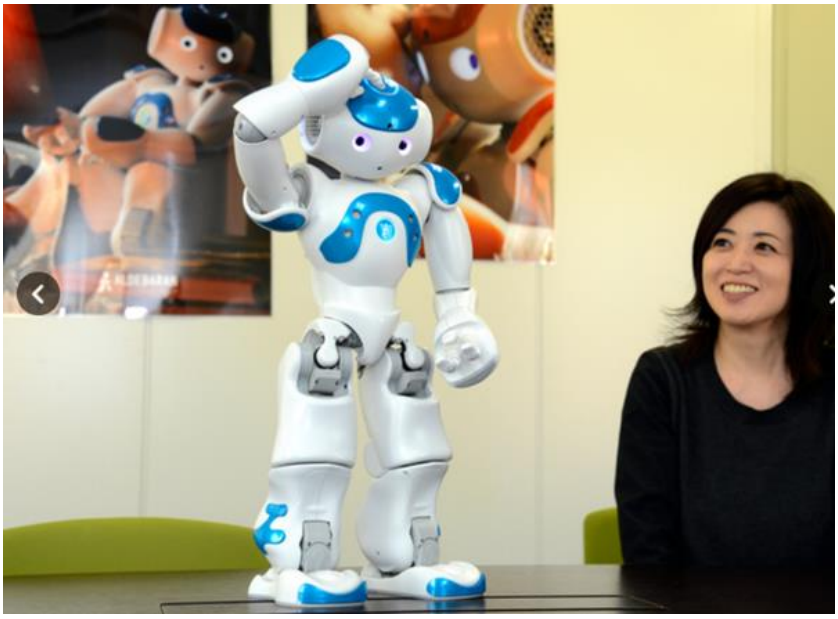

Fig. 8 NAO in BiblioBattle at Yukuhashi library[9]

3. Use of Robots for Library Technical Services

3.1 Reduction of Physical Burden by a Robot Suit

Many library materials are heavy. Especially when inter-library loans (ILL) are done, there are many cases where many books are put in one box. The robot suit "HAL", developed by CYBERDYNE, a venture company from the University of Tsukuba, has a mechanism in which a sensor reads a signal sent from the operator's brain to a muscle. The motor of the airframe is attached to the waist and helps to support human movement. According to CYBERDYNE, wearing the "HAL" suit has the effect of reducing the burden on the lower back by up to 40%. At Tsukuba City Central Library, two "HALs" have been introduced to reduce the burden on the staff and a reduction of reported back pain.

Fig.9 Robot Suit “HAL” at Tsukuba City Central Library

3.2 Automatic Tracking Book-Transport Robot

In addition to “HAL”, the Tsukuba City Central Library has introduced other robots to reduce the burden on librarians. The transport robot “THOUZER”, developed by the venture company Doog in Tsukuba city, can automatically track the lead librarian and transport a package of up to 120 kg. When a staff member places a book on “THOUZER” and presses the button for automatic follow-up, the robot checks the surroundings and follows behind the staff member with automatic travel by using a laser sensor. If there is an obstacle, it will stop automatically. At Tsukuba City Central Library, “THOUZER” is used for collecting books placed in the return post when there are no users in the library, and it is effective in reducing the burden on staff.

Fig.10 Book-Transport Robot “THOUZER” at Tsukuba City Central Library

4. Application of Artificial Intelligence Technology in Library

A library can be used to produce big data because it contains an assembly of intellectual products, a large number of materials, and historical information about how the library was used. Therefore, in Japan, there has been a rapid spread of attempts to use such big data from libraries for artificial intelligence research.

For example, “UEC Ambient Intelligence Agora”, which was opened in 2017 at the University of Electro-Communications, is an organization built in collaboration with the Research Center for Artificial Intelligence and the Library of the University of Electro-Communications. It analyzes the data accumulated in the library as big data and uses them for artificial intelligence research as well as to provide feedback to the library[10].

Fig.11 UEC AIA HomePage [10]

In addition, the Academic Theater of Kindai University analyzes people's characters by using content posted on SNS, and provides a service to introduce books that most closely match the potential interest of each person. This service is conducted by collaborating with a Twitter or Facebook account, analyzing the content of the post, and calculating the scores of the five characteristics of openness, integrity, extroversion, harmony, and neuroticism. Furthermore, in this service, the book reviews of 70,000 books collected by BIBLIOTHEATER, which is part of the library of Kindai University, were analyzed, the scores were calculated in a similar way, and the book with the closest score is introduced[11].

Fig.12 The Result of the service to introduce books using content posted on SNS at the Bibliotheater in Kidai University[12]

Such applications of artificial intelligence technology to libraries and reading activities are being seen more frequently at the research level or trial production stage. For example, the author has developed and provided the reading support game software “KOKORO Saver” based on expressions in the book review for a novel. In this software, users can enjoy the Story Book type game, in which well-known stories such as fairy tales change according to the choice of actions by users. At the end of this game, books are recommended based on the user’s choices of action at each scene in the game and on 15 elements, such as “Happy-Sad”, “Funny-Serious”, “Safe-Disturbing”, and “Expected-Unpredictable”, which are related to the feelings after reading the expressions used in the book reviews[13][14].

5. Summary

The application of robots and artificial intelligence technology in Japanese libraries is just beginning to progress steadily. At the present time, the use of robots is mainly for library guidance, but new applications are expected in the future.

Acknowledgments

I would like to thank Tsukuba Public Library, The YAMANAKAKO Public Library for the People's Creativity, Konan University Library, Edogawa City Library Shinozaki Library, Academic Theater/Biblio Theater library at Kindai University, Kitami Institute of Technology Library, TRC Library Service Inc. and Dr. Tomohiro Umetani for their help in the survey.

Fig.13 The Poster of "KOKORO Saver" in IFLA 2018[13)]

References & Notes

1) Takashiro Maruytama. Introduction of humanoid robot in library: Aiming at the making of a library to feel the future. The Library Journal. 2018, Vol.112, No.7, p.456-457. (Japanese)
2) Photo by YAMANAKA Public Library for the People's Creativity.
3) Ryosuke Mochizuki. Peppers answer and question in libraries: What is the challenge of TRC Library Service Inc. that introduce "Pepper" to 500 libraries in Japan. Robosta. <https://robotstart.info/2016/08/03/trc-pepper.html> (accessed 25.06.2019)(Japanese)
4) Headwaters Co., Ltd. Robot Book Search : Pepper as an Assistant for Book Search. <https://www.headwaters.co.jp/service/pepper/booksearch.html> (accessed 24.06.2019) (Japanese)
5) Kodai Okada, Kazuki Yoshioka et al. Guide Robot "KoRo" Located at the Entrance of the Library. The Robotics and Mechatronics Conference. 2016, 1A1-14b1. <https://doi.org/10.1299/jsmermd.2016.1A1-14b1> (accessed 20.06.2019) (Japanese)

6) Kinokuniya Company Ltd. Library and AI Research: University of Electro-Communications UEC Ambient Intelligence Agora. <https://mirai.kinokuniya.co.jp/2018/02/3176/> (accessed 28.06.2019) (Japanese)
7) Soji Kawamura. Development of Guide Robot to get close to Library <http://www.innovativ-kosen.jp/dev/%E5%B9%B3%E6%88%9029%E5%B9%B4%E5%BA%A6%E6%97%A5%E5%B7%A5%E6%95%99%E3%82%AA%E3%83%BC%E3%82%AC%E3%83%8A%E3%82%A4%E3%82%BA%E3%83%89%E3%82%BB%E3%83%83%E3%82%B7%E3%83%A7%E3%83%B3%E3%81%AE%E5%A0%B1%E5%91%8A/?action=common_download_main&upload_id=1280 > (accessed 18.06.2019) (Japanese)
8) Shimotsuke Original Online News. Guide Robot "Usa-tan" 4th generation dispatch. <https://www.shimotsuke.co.jp/articles/gallery/11135> (accessed 20.06.2019)(Japanese)
9) Yuzo Hisatsune. Recommended by robots : a unique book conference at Yukuhashi. Asahi Shimbun Company (Asahi- Shimbun Digital) 10-10-2018. <https://www.asahi.com/articles/photo/AS20181009002990.html> (accessed 25.06.2019) (Japanese)
10) The University of Electro-Communications. UEC Ambient Intelligence Agore HomePage. <https://aia.lib.uec.ac.jp> (accessed 28.06.2019) (Japanese)
11) Daisuke Teramoto, Takahiko Sugao. Matching service with books utilizing AI from Kindai University. Joho-No-Kagaku-To-Gijutsu. 2018, Vol.68, No.12, p.596-599 <https://doi.org/10.18919/jkg.68.12_596> (Japanese)
12) Academic Theater. Diagnostic Content. <https://act.kindai.ac.jp/personality_test/> (accessed 30.06.2019) (Japanese)
13) Yukinori Okabe, Takashi Harada et al. The development of the book report creation support game. Paper presented at: IFLA WLIC 2018 – Kuala Lumpur, Malaysia – Transform Libraries, Transform Societies in Session 153 - Poster Session. <http://library.ifla.org/2401/> (accessed 25.06.2019)
14) Takashi Harada, & Library and Information Science Laboratory. Doshisha University. Biblio-Game KOKORO Saver. <http://www.slis.doshisha.ac.jp/KOKORO/> (accecced 04.04.2019)