Robot-Assisted Language Learning: Scientific Data Analysis

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Abstract

Robot-assisted language learning (RALL) is a direction in education that uses robots in the process of studying foreign languages. In this paper, we present the results of our research work devoted to studying trends in the quantity of publications in the field of using social robots for learning foreign languages. Additionally, we have analyzed some published paper in the field of RALL, which has allowed us to identify several popular robot models used in practical research in recent years. Among these models were the NAO, Pepper and DARWIN OP-2 robots. We have found that these robots are actively used in the educational process for learning foreign languages. In particular, these models are used to improve language and communication skills during implicit learning and interactive games.

Keywords: Robot-assisted language learning, Foreign language learning, Robot teaching assistant, Social robotics

1. Introduction

The last decades have seen significant progress in the field of Artificial Intelligence (AI), which has become an integral part of human life. This development has resulted in the emergence of many systems with the ability to replace certain aspects of human activity. Modern AI systems are innovative technological solutions capable of functioning effectively in various fields of activity, including manufacturing, medicine, finance, transportation, and others. Some studies speculate about the prospects of symbiosis of human and cybernetic systems [1]. Robotics is closely related to artificial intelligence and also applies the results of progress in this area [2]. Thanks to artificial intelligence, it is possible to generate a three-dimensional space for robot testing in simulation [3], generate a maze [4] and create obstacles to further calibrate algorithms for complex tasks [5]. Robots, thanks to machine learning algorithms, are able to navigate in the Gazebo simulation environment [6], [7], in real-world environments [8], and can also follow humans [9] and independently plan a route to move [10].

The significant achievement of robotics is the direct assistance to humans, which makes this field in demand nowadays. Modern robots perform a huge range of tasks: they can provide the necessary assistance to the elderly [11], they can be used for medical procedures and examinations [12], [13] and find application as personnel in hospitals [14], and they are also used in areas of high risk for humans, in rescue operations [15].

Currently, robotics is widely used in education [16]. There it finds application in the creation of programs and exercises for students [17], as well as can be an assistant in learning foreign languages [18]. The use of social robotics in education has great potential and is of significant interest to researchers in both the humanities and technical fields of science. Robot assisted language learning (RALL) is a direction in education that uses robots in the process of studying foreign languages. Education using robots is aimed primarily at increasing student motivation and the degree of interactivity of the learning process itself, as well as adapting the educational process to the individual needs of students.

The aim of this paper is to study the dynamics of the number of publications devoted to the use of social robots for learning foreign languages. Additionally, we will examine the robot models used by researchers in the field of RALL.

2. Analysis of Publication Activity in the Field of RALL

In order to assess the interest of researchers in the field of RALL, we counted the number of published papers for the query "robot-assisted language learning" in the Google Scholar search engine. In total, based on the results of this search query, we received more than 900 scientific papers. Among the collected papers, we have selected those published no earlier than 2010 (totaling 889 papers) and counted the number of publications in each year from 2010 to 2023. The resulting diagram of the number of published papers in each year is presented in Fig. 1. Based on the diagram presented in Fig. 1 we can conclude that interest in social robotics and, in particular, in robot-assisted language learning has increased over the last decade.

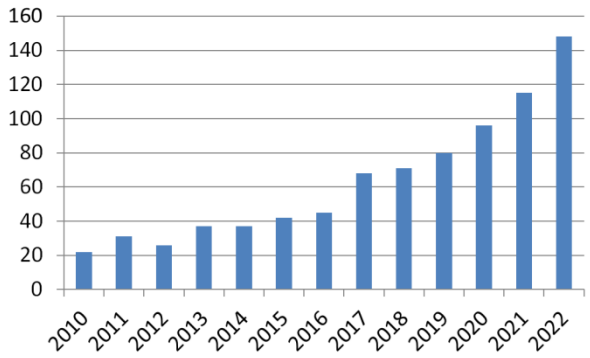

Fig.1 A number of published papers (X-axis) on robot-assisted language learning in the Google Scholar search engine per year (Y-axis)

According to Fig. 1, starting in 2019, interest in robots assisting with foreign language learning began to grow noticeably. Thus, among the papers presented in the search results there were 80 papers published in 2019, and 148 papers published in 2022. This increase in interest may be attributed, among other factors, to the impact that the COVID-19 pandemic has had on the methods of communication in society in general, and within educational systems in particular. Due to restrictions on traveling and face-to-face meetings, many people have turned to online education and digital solutions to learn foreign languages. Robots capable of teaching languages provide a convenient and affordable way to learn virtually. This has further influenced the growth of technology in this field. These results confirm that social robotics and robot-assisted language learning have great potential and will continue to attract the attention of researchers and society at large.

3. Robot Models Used in RALL

To identify the robots currently utilized in robot-assisted language learning research, we conducted an analysis of around 100 papers derived from the search query "robot-assisted language learning" in the Google Scholar search engine. Among the most popular models of robots used in practical research were the NAO robot and the Pepper robot from SoftBank Robotics, as well as the DARWIN-OP2 robot from ROBOTIS.

The NAO robot model was referenced in 3 research papers [19], [20], [21]. The study [19] examined the impact of the NAO robot functioning as a teacher's assistant on university students' English vocabulary improvement. The research [20] implemented a system of implicit learning utilizing two NAO robot models. In study [21], the NAO robot was utilized in teaching a second language to 5-year-old children. Two research papers [22], [23] referenced the Pepper robot model. In [22], the Pepper robot was employed for interactive game-based learning in single-user and team versions of a quiz game. In study [23], a project was presented which involved the Pepper robot being used as the basis for developing for robotic teaching of the endangered Ainu language. The DARWIN-OP2 robot was also mentioned in two research papers [18], [24]. The study [18] presented the experimental verification of English language lesson scenarios with the DARWIN-OP2 robot in the Gazebo simulator. The study [24] introduced a pilot experiment involving the interaction of preschool children aged 5-6 years with the DARWIN-OP2 robot, serving as a teacher's assistant.

4. Discussion

In this section, we provide the general characteristics of the NAO, Pepper, and DARWIN-OP2 robots, and also review key characteristics of the studies presented in the previous section.

The robots NAO, Pepper, and DARWIN-OP2 share characteristics that make them attractive for research in the field of RALL. The robot NAO has small dimensions - about 58 cm in height, and a humanoid form with a head, arms, and legs. The DARWIN-OP2 robot has more compact dimensions - about 45 cm in height, and a simpler design. Pepper is a taller robot - about 120 cm in height. Like NAO and DARWIN-OP2, Pepper has a head and two arms. However, unlike NAO and DARWIN-OP2, Pepper does not have legs, and overall, Pepper has a more monumental appearance. Overall, the visual design of all three robots is conducive to social interaction.

From the point of view of using these robot models in an educational environment when learning foreign languages, all three robot models also have a number of common attractive characteristics. First of all, these models are programmable models and can be adapted to various educational contexts. From a technical point of view, robots NAO, Pepper and DARWIN-OP2 provide ample opportunities for speech synthesis and recognition, integration of computer vision and machine learning. All this allows researchers to achieve a high

level of human-robot interaction, including the interaction with children.

In Table 1 we provide a comparative analysis of some of the characteristic features of the studies we indicated in previous section, in which the NAO, Pepper and DARWIN-OP2 robot models were used.

Table 1. Key characteristics of studies using the NAO, Pepper and DARWIN-OP2 robots.

The application area	
NAO	Assistant English teacher for university students improving their vocabulary. Implicit learning through conversation.
Pepper	Studying English grammar in universities. Learning an endangered language.
DARWIN-OP2	English lessons with preschool children.
Objectives of the experiments	
NAO	Studying the effect of a robot on improving students' vocabulary.
Pepper	The effectiveness of game-based learning.
DARWIN-OP2	Interaction with preschool children in English lessons.
Distinctive features of the studies	
NAO	The use of implicit learning as a primary learning style.
Pepper	Using a robot as a play partner with an educational interactive quiz.
DARWIN-OP2	The optimization of the English language learning process with the help of the Gazebo simulator and global human-robot interaction scenarios

From the presented in Table 1 training scenarios, it can be concluded that the NAO, Pepper and DARWIN-OP2 robots demonstrate a wide range of capabilities in the context of educational environments. They have been successfully used in university classrooms, ranging from helping students learn foreign language and improving students' vocabulary to using them in game-based learning. In addition, these robots successfully interact with preschool children, optimizing the language learning process using advanced simulators and global human-robot interaction scenarios. Thus, learning cases using these robots reflect their applicability in various educational contexts and their ability to effectively support and improve students' language skills.

5. Conclusions

Our analysis of the number of published papers related to "robot-assisted language learning" demonstrates a steadily growing interest among researchers in the RALL field. Data obtained from a Google Scholar search show a noticeable increase in the number of publications since 2019, indicating a growing interest in robots helping with foreign language learning. This increase in interest can be partially attributed to the impact of the COVID-19 pandemic, which has prompted a shift to online education and digital language learning solutions due to travel restrictions and social distancing measures. Among the most frequently used robot models in RALL research were the NAO, Pepper, and DARWIN-OP2 robots. These robots are used to improve language skills and communication in a variety of educational scenarios, including implicit learning and interactive games.

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