A Review of Robots in Caring for the Elderly

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Abstract: This literature review mainly talks about robots in caring for the elderly. With the intensification of global ageing, the number of elderly people is constantly increasing. The growing elderly population and the escalation of low fertility have led to certain nursing challenges. In order to deal with these problems and reduce the pressure on nursing staff, many caring robots are put in use. The elderly are the primary target of care provided by caring robots, both emotionally and medically. They have the ability to provide emotional support to the elderly as well as take care of the day-to-day activities of the aged. When it comes to providing care for elderly people, robots too face a few challenges. However, as caring robots are used more and more, people have a more positive understanding of them. In the future, caring robots will be more intelligent. Not only are they useful for personal care, but they also play a significant role in the delivery of community and social services.

Keywords: Caring robots, Elderly care, Development directions

1. Introduction

As the global ageing population continues to expand, individuals face increasing demand on healthcare systems. The ageing of the population is characterized by the increasing number and proportion of the elderly, while the decreasing number of young people. With the improvement of medical care, people's life expectancy is extended. The elderly population itself is also ageing. According to Anthea Tinker [1], older people are more likely to suffer from long-term diseases. This limits their activities, leads to several functional issues, and increases dependence on healthcare services. Therefore, robots are increasingly employed to assist the elderly.

For the elderly, they have to face many health problems. With advancing age, the physiological functions of the elderly deteriorate. Their vision, hearing, touch, smell, taste, and pain sensitivity all significantly diminish with age. Decline in cognitive ability and physical function will make the elderly need the help of external factors. The elderly need dietary and nutritional care, personal hygiene and cleaning, dressing and mobility assistance and even ensuring that they take medicine on time [2]. Some elderly people living alone also suffer from emotional pressure. They feel lonely and have strong social needs, otherwise it is likely to cause depression and anxiety disorder. Therefore, the elderly are at risk of being isolated by society and unable to live alone.

These factors have led to the increasing requirements for elderly care. In today's low-birth society, it puts a lot of pressure on the family to employ a traditional carer for the elderly. Therefore, more and more caring robots are put into the ranks of taking care of the elderly. It is a great choice to provide physical and mental support for the elderly through intelligent robots.

2.   Caring Robots

2.1.   History of robotics

The origin of the word "robot" comes from the Czech word "robota," meaning "heavy work" or "forced labor." According to the article "A Brief History of Industrial Robotics in the 20th Century," the introduction of this term is due to the Czech writer Karel Čapek (1890-1938), who used it for the first time in 1920 in his novel "Rossum's Universal Robots" [3]. On the other hand, the history of industrial robots can be traced back to the 1950s. It can be seen that robots are developing very rapidly.

2.2.   Application of caring robots

Robots in elderly care are usually divided into two categories [4][5]. One of the robots in health care provides rehabilitation services and assists in daily activities. Another type of robot is the social robot.

In the article "Robots in Elderly Care," the elderly with mild cognitive impairment can be treated with the doll and/or pet therapy [6]. Therefore, dolls and pets can be used as psychological treatment tools to regulate the mood of the elderly and reduce dependence on psychotropic drugs. Now, robots can replace dolls and pets, improve the social experience of the elderly, and even become a tool for the elderly to contact the outside.

Kazuko Obayashi and Shigeru Masuyama investigate the possible impact of sensing systems supported by communication robots and cloud robots on caring for the elderly [7]. The experiment invited two elderly people and four nurses from the nursing home to participate. Evaluate the rhythm of the elderly's night life and determine how to put the system into nursing work. The research was very successful. The results show that first of all, communication robots can motivate the elderly to communicate with others and participate in social activities. Secondly, robots can effectively reduce the workload of night shift nurses. Third, using robot sensors to automatically record the information of the elderly can improve the quality of nursing. Communication robots with sensors can detect the daily life of the elderly and issue alarms when the elderly encounter emergencies.

2.3.   Examples of caring robots

Sony has developed an entertainment robot, "AIBO." This robot looks like a metal dog. It is equipped with a touch sensor, through which it can detect distance, acceleration and other data, and distinguish its name and more than 50 verbal commands from the sound it hears. Moreover, it can also distinguish certain colors, such as pink. It can express its "emotions" by making sounds and cooperating with a set of actions such as walking, shaking claws and chasing the ball [8]. It can also provide people with emotional value through learning.

The Collaborative Healthcare/Home Assistant Robot was manufactured by Minho Industrial Electronics (CHARMIE) [9]. It is a humanoid auxiliary robot with health care and home care functions. It can perform various types of tasks in non-standardized indoor environments and some outdoor environments. Therefore, it can play an important role in nursing homes, hospitals, health care centers and families. The tasks it can complete include picking up and placing items, transshipment of goods, tracking patients, voice communication (listening and speaking), visual analysis of the surrounding environment, item recognition, and navigation. In terms of collaboration, the robot performs excellently. It can help the elderly solve chores and even help the elderly complete work that cannot be done alone. Here are some examples: provide food to people lying in hospital beds, distribute crutches to the elderly in nursing homes, transport boxes of medicines between different areas of medical institutions, and clean up a table or load a washing machine at home. The hardware of the robot can be divided into four parts: (1) motion platform; (2) robot arms; (3) lifting mechanism and torso; (4) robot head. The anthropomorphism of the robot shape is conducive to

people who interact with robots to gain a sense of comfort or friendliness. Considering the stability and simplicity, motion platform is not anthropomorphic (human-like feet). In order for robots to make complex movements, many parts have been customized. Four omnidirectional wheels with independent suspension systems were used on the developed motion platform. This allows the robot to still have good passing ability when facing irregular floors, bumpy roads and slopes. In order for the robot to work at different heights, the robot has Z-axis DOF. The robotic arm is a kind of human-like design. It has four degrees of freedom and can easily grab items. The head of the robot is equipped with an RGB-D camera, a multi-mode user interface and a microphone. In order for the robot to perform tasks safely in the environment, the sensor system should have the following four functions: establish maps and self-positioning, obstacle detection and avoidance, user posture/gesture detection, object detection and follow-up operation. I believe that this robot can improve the quality of life of the elderly in the future.

An integrated smart home robot named RISH for taking care of the elderly [10]. This robot integrates home service robots, home sensor networks, body sensor networks, mobile devices, cloud servers and remote caregivers. It has a sensitive auditory system, and sound-based human activity detection can quickly detect the elderly's fall and provide timely rescue. Through experiments, it is found that the whole system is running well and can achieve human activity recognition with an accuracy rate of more than 86%. Even if the robot's camera is blocked and cannot be observed, it can still detect silent falls by integrating multiple sensors in RISH. In the future, this model will be further tested on various occasions, making an important contribution to the detection of the fall of the elderly.

2.4. Problems of caring robots

Because robots in elderly care are a new kind of technology, they will cause some problems compared with traditional nurses, and people also have some distrust of it.

The existence of caring robot technology reduces the contact between the elderly and society, materializes the elderly, and increases the risk of the elderly losing their personal freedom (especially when robots perform restrictive intervention tasks) [6]. Some robots have too few single conversational functions, and they are used as companions to accompany the elderly because of their cute appearance (such as Paro the seal). However, robots do not play the role of partners. They can only be used to relieve the family's guilt for the elderly living alone.

In the management of caring work, privacy protection is very important. Especially in the care of the elderly, it is inevitable to obtain the personal information of the elderly. How to protect the privacy of the elderly and ensure that robots do not leak information will be a thorny problem [7]. In order to protect privacy, the data can be preprocessed on the client, reduce the transmission of privacy-sensitive data, and use non-privacy-sensitive means for nursing services. At the same time, the national level should formulate policies and regulations to regulate the whole process of collection, transmission, processing and storage of privacy data and establish a risk warning mechanism.

Furthermore, the contradiction between nurses and robot investors is also considerable [11]. Nursing staff hope to help complete repetitive work through caring robots, so that they can better devote themselves to nursing work. However, robot investors hope to make nursing more efficient and cost-effective by developing caring robots to replace the work of nurses. The developer of the robot is not a professional nurse. This means that the technology of caring robots pays more and more attention to standardization and the selection of "reasonable" nursing measures. And the "reasonable" of robots means economic benefits and best-selling index. As a result, the caring robots produced reduce the dependence on traditional nursing knowledge. Ultimately, this will result in nursing becoming increasingly unprofessional.

2.5. The positive aspects of caring robots

With people's in-depth understanding of caring robots, its positive role gradually emerges. This study compares the performance of robot coaches and human coaches in two types of activities through controlled experiments. It is used to evaluate the feasibility of robots entering elderly care services, and also listened to the suggestions of the elderly involved [12]. According to the research results, robots can motivate the elderly to exercise better than human coaches. Humanoid robots have great potential as sports guidance and information transmission agents for elderly users. In the future, it is still challenging to explore the principles of robot design for the elderly so that robots can share and reduce the workload of human beings in elderly care services.

The second survey of elderly care employees in Finland in 2020 showed that their attitude towards caring robots has changed positively compared with 2016 [13]. Research proves that value-based evaluation is very important in the process of receiving caring robots. Useful views on caring robots are not only affected by the increase in the time of contact with robots, but also by personal value and the compatibility of robot use. Nurses believe that the use of caring robots is in line with their personal values, which makes them see the potential of caring robots and will make them more willing to use caring robots in the future.

3. Application Examples

This study aims to investigate users' satisfaction with robots that implement services in the elderly care program [14]. In this survey, the researchers installed a robot, *Peppe,*r in the facility. *Pepper* is a human-like robot. It looks like a little boy in terms of appearance, voice and tone. The original intention of its design is to provide people with the joy of communication and improve the quality of life in daily life. *Pepper* can recognize the user's voice and talk to the user through words and phrases. It is equipped with a touch screen on its chest. Therefore, it can use gestures and voice as well as the information displayed on the touch screen to communicate with people. The robot Pepper is used for two types of nursing programs: exercise with cognitive tasks and brain training with arithmetic transport. Through the questionnaire, it was found that the nursing plan using robots is effective, but the efficiency is relatively low. The effectiveness of nursing depends on the type of care required by the elderly and the current physical condition of the elderly. In addition, the degree of acceptance of technology by the elderly is a key factor in the effectiveness of robots. The current nursing plan still needs to be improved. It is necessary to achieve better robot nursing and improve the acceptance of robots in the social environment of elderly care.

Another study explores users' assumptions, expectations and understanding of caring robots through interviews with participants. The results show that the implicit and integrated knowledge in nursing practice is important for how to build caring robots, which are technical solutions to overcome the challenges faced by elderly care [15]. Participants' understanding of nursing quality, control and employment is reflected in the technical framework of caring robots as human substitutes and the nature of human nursing, and affects their willingness to accept caring robots. In addition, the experience of using caring robots and the cognition and education of caring robots are very important, which can help people get rid of the fictional fear of caring robots.

4. Discussion and Conclusion

Based on the above analysis of the advantages and disadvantages of care robots, in the future, there may be several development directions for elderly robots.

With the advancement of artificial intelligence (AI) and machine learning technology, caring robots will become more intelligent and able to provide more accurate and personalized nursing services. In the future, care robots can collect and process more health data through big data, as well

as better anticipate patients' needs and respond in advance, thus improving the efficiency and quality of care.

Caring robot products will develop various types and forms of products according to different application scenarios and target user groups. For example, there are companion robots (AIBO, Paro) specifically for the elderly and auxiliary robots (CHARMIE) for the disabled. Through deep learning and data analysis, caring robots will be able to better understand the unique needs and preferences of each user and provide personalized services. Future robots will have stronger learning ability and adaptability, and can better understand and meet the needs of the elderly. The level of intelligence will be further improved. In the future, humanoid robots for the elderly will no longer be limited to a single function, but will develop in the direction of multi-functional integration. In addition to daily life assistance, health management and other functions, robots will also integrate more intelligent modules, such as smart home control, telemedicine consultation.

With the expansion of the industry, raw material suppliers will be more professional and large-scale, providing caring robot manufacturers with higher quality and lower-cost raw materials. This will gradually improve the quality of caring robots.

Finally, solving users' privacy issues is a top priority. As elderly humanoid robots collect a large number of users' personal information and health data in the process of providing services, how to ensure the security and privacy of these data is a problem that enterprises must face. Enterprises should establish a sound data management system, use encryption technology to protect user information, and prevent data leakage.

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