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The Attractive Factors of Serving Robotics in Medical Institutions and User Interaction

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Abstract

Taiwan is facing demographic changes. Due to the dual impacts of aging and declining birthrate, how to respond to the demographic challenges and meet the future demand for medical services has become an important concern in the community. With the engagement of artificial intelligence and robotics technology in recent years, various new types of robots have been created, and service robots are developing rapidly. The applications of service robots include tour assistance, company, and cares. It overcomes the shortness of staff and the limited services in the medical institute, providing service and fitting the clients' demand. This paper takes the Pepper, a service-oriented robot, as an example to investigate the relationship between human-computer interactions by the evaluation grid method.

The study uses interviews to obtain the attractive factors of human-computer interaction. Results have shown that functionality and appearance are the most crucial factors. The robots receive the users' attention, results in not only better interpersonal communication between medical institute and user, but releasing users stress while in waiting for medical treatments. Finally, the research is summarized into recommendations, such as the addition of barrier-free design, direct guidance, voice recognition, multiple languages, medical games, and time limits, which can be used as a reference for future industries or research.

Keywords：Medical center, Service robot, Human-computer interaction, Attractiveness factors, Evaluation grid method

1. Introduction

Taiwan's society is facing the impact of demographic imbalance from the issue of slow birth rate and aging population. To compensate for the lack of labor force, many companies have been gradually introducing robots as the replacement for laborers. The service-oriented machines thus have become one of the important development strategies of many governments (Kuniaki Noda, 2014; Tom Sorell, 2014). Moreover, because of the COVID-19 pandemic, many countries are reconsidering the implementation of robots, especially in medical institutions. Medical institutions liked hospitals are running with a shortage of nurses under the threat of a pandemic. How to reduce the contact between health careworkers and patients become an important issue. Inadequate protective measures will not only put the care takers at risk but also the patients (Rickman et al., 2020; James et al., 2020). Therefore, countries are actively investing in the research and development of service-oriented robots to alleviate the tasks such as condition inspection, environmental disinfection, interpersonal communication, and delivery of goods.

Facing the series of problems on the aging population, rising costs, and staff management, the medical institutions have started using service-oriented robots to assist the regular tasks liked patient registration, navigation maps, question interpretation, and companionship. The main object of this work is to investigate the interaction between service-oriented robots and peoples. The Evaluation Construct Method will be used to specify the attractiveness factors that attract the subject's attention to operate the service-oriented robots. The results can provide a good foundation for future research on the human-machine interface.

2. Literature review

2-1 Human-Computer Interaction

Since 1980, Human-Computer Interaction (HCI) has been widely used to describe the interaction between the users and machines (Preece et al., 1994). According to the needs of user's operation, the interface design can be divided into Tangible User Interface (TUI) on which enables the users to interact and operate straightforwardly, and Natural User Interface (NUI) which creates interactions and deliver messages through gestures or movement recognition by the machine (Authors, 2009； Huang et al., 2014).

2-2 Pepper Service Robot Features and Applications

Due to the explosion of COVID19, countries are using service robots in medical services to reduce staff load, and service robots are good at repetitive tasks and have less error rate than humans (Tuuli Turja, 2020). Service-oriented robots are designed to support healthcare workers, share their workload, and reduce the risk of exposure to infection (Liu et al., 2020). In response to the demand of robots in the market, manufacturers in Taiwan also have invested in the development of robots (i.e the Pepper robots) on services, entertainment, and problem-solving (Dignan, 2014).

One of the applications in using Pepper robots for human service is the library in Australia where has introduced Pepper robots to its children's library services. By adding the entertainment function in the robots liked the interactive games, it can attract interest from parents and children (Tatham, 2016). The library in Japan also has introduced Pepper as a service robot to provide tour guides, consultation, and book borrowing functions,

which can effectively help the librarians to share the workload and provide a friendly reading environment (Takahiro, 2016；Ryosuke, 2016). The stores in Brussels Airport have introduced Pepper service robots to sell chocolate products for high interactivity, good shopping experience, and impression (Laurens et al., 2018). These cases present the great potential of Pepper in various applications. Thus in this work, a service-oriented robot liked Pepper would be evaluated for the medical institution as an example to explore the user's experience of human-machine interaction.

2-3 Evaluation Grid Method

In 1998, Japanese scholar Masato Ujikawa established Charming Institute for studying the charm engineering. Charm engineering is included as part of perceptual engineering (Chen et al., 2011). In 1885, the Japanese scholars Junichiro Sanui and Masao Inui developed a method for evaluating the constructs, called Evaluation Grid Method (EGM). This method is one of the most important methods in charm engineering, and it was derived from psychologist Kelly's book "The Psychology of Personal Constructs". EGM can be divided into original reasons, specific issues, and abstract reasons (Kelly, 1991). The progress of EGM is to interview the subjects who have already used the products, asking the subjects to recall the original reasons that the products attract them during the product's experience. Afterward, have the subjects illustrate the specific items and describe their feelings about the products. Finally to transform the interview results into the evaluation structure chart. The EGM has also been widely used in various fields with good results (Chen et al., 2012). Therefore, in this work, EGM is used as the research method to explore the user's inner feelings on Pepper's service robot.

3. Research Steps and Analysis

In 2017, a medical institution in Taichung introduced the Pepper service robot for regulars tasks such as registration, consultation, navigation, communication, and entertainment. To obtain the attractive factors that attract users to use Pepper's service-oriented robot, this work uses interviews to understand users' feelings. The analysis results could provide a reference for future medical institutions in planning the service-oriented robots.

3-1 Methodological steps and participant analysis

This work aims to understand the user's experience of using Pepper's service robot in a hospital in Taichung.

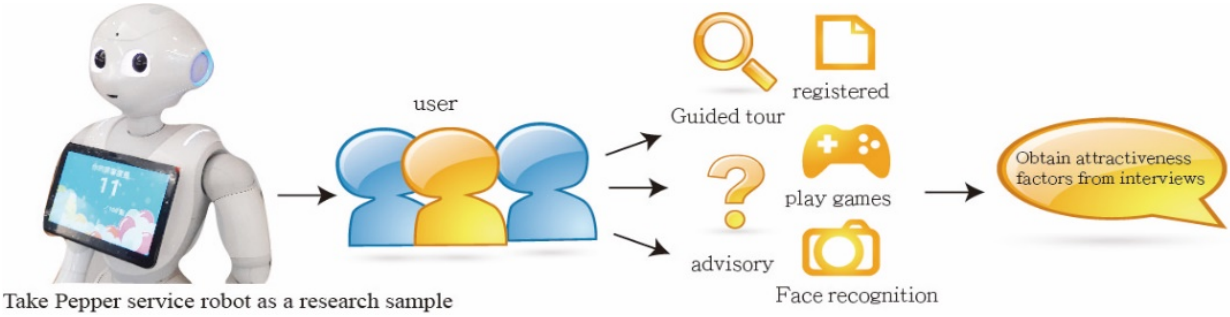

Figure 1. Schematic of Research progress

The researcher first observes the interaction between the user and the Pepper service robot in the medical institution. The interview is taking place right after with the users' willingness. The interview outline is shown in Table 1.

Table 1. Interview outline

No.	Interview tasks and questions	Purpose
1	Observe the interaction between the test subjects and Pepper's service-oriented robot	Observe the interaction between the test subjects and Pepper's service-oriented robot
2	Why would you like to use Pepper's service robot? (Original reasons)	
3	What is the characteristic that Peppers' service robot attract you? Could you describe in specific and details? (concrete fascination factors)	
4	What is your feeling about the mentioned characteristic (abstract fascination factors)	
5	Observe the interaction between the test subjects and Pepper's service-oriented robot	
6	Why would you like to use Pepper's service robot? (Original reasons)	Ask for the consent of the test subjects before conducting the interview
7	What is the characteristic that Peppers' service robot attract you? Could you describe in specific and details? (concrete fascination factors)	
8	What is your feeling about the mentioned characteristic (abstract fascination factors)	

3-2 EGM network for Users

The data analysis method is mainly based on the Evaluation Grid Method. Firstly, lets the subjects describe the primitive fascination factors that attract them to use Pepper robots. Secondly, ask the subjects to specify the concrete fascination factors and describe their inner feelings about the experience with Pepper robots. Then analyze the interview results and conclude in the evaluation structure diagram, as shown in Figure 2.

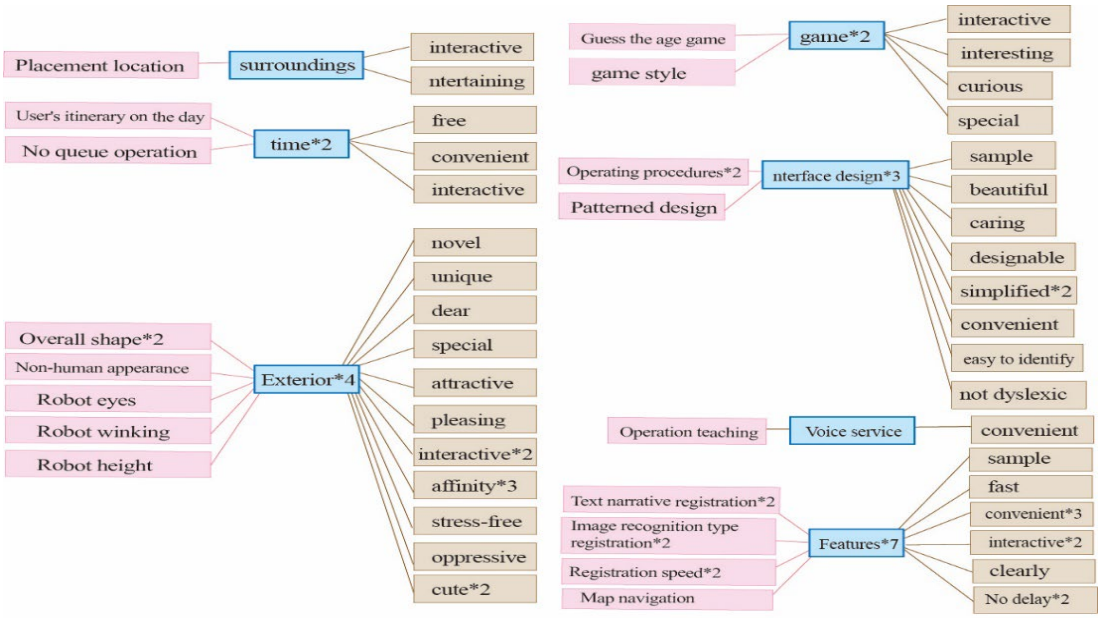

Figure 2. EGM network interviewed by the test subjects

In this study, the interview data were mapped into an EGM network (e.g., Figure 2) based on the Evaluation Grid Method. With the mapped results, we can clearly understand how the subjects feel about using the Pepper robot and the specific factors.

4. Results and Discussion

4-1 Attractiveness factors that attract users to use (primitive fascination factors)

From the interview results, it could conclude seven important primitive fascination factors that attract users to operate the service robot, including the operation environment 5%, time saving10%, robots' appearance 20%, robots' function 35%, games 10%, the interface design 15%, and the voice service 5%. Among all the seven primitive fascination factors, functionality is the most important attractiveness factor. In this paper, the interview data are compiled by using the evaluation structure method, and the analysis results are shown below:

(1) Primitive fascination factors—Environment (5%)：Users felt that the location of the Pepper robot is important. Placing the robot in an obvious place liked the hospital lobby would help attract users to use it.

(2) Primitive fascination factors—Time(10%)：Pepper robot can assist patients to register, thus the patients do not have to line up in front of the traditional counter or waiting for the call to get registered, bringing more convenience to users. Moreover, patients can have more interaction with Pepper while they ate not in the rush of time.

(3) Primitive fascination factors—Appearance (20%)：Pepper robots do not design to completely look like the human. The Pepper with only 121 cm height makes them close to the users. Test subjects said that if the robots looked humane too much can be frightening and intimidating. As Pepper's robot has cartoon-like eyes and will blink from time to time while talking, the test subjects feel an affinity.

(4) Primitive fascination factors— Robots' Function (35%)：The robots have several built-in functions, like introducing themselves to users, using body language while interacting, working with face recognition, and having interactive entertainment games. The most attractive feature is that the Pepper robot can provide service by voices, and the panel on the robot will display the images of the human's body, allowing the users to register directly by touching the body parts they want to have the treatment on the screen. Moreover, Pepper's robot has a dynamic navigation map to help users locate the hospital building, which is a very convenient function.

(5) Primitive fascination factors—game(10%)：Pepper robot has a variety of interactive games to interact with users, among which the age-guessing game is a very popular one. Users feel it entertaining and interesting. The interesting part is that the Pepper robot will show the users' age that is lower than the actual age. For example, an old man is 62 years old, then Pepper will guess he is 58 years old (Figure 3). Afterward, Pepper will ask this old man whether it is correct? If he said it is wrong, then Pepper robot will smile and say "because you look particularly young" to make the old man happy. Thus it increases interactivity between Pepper and users.

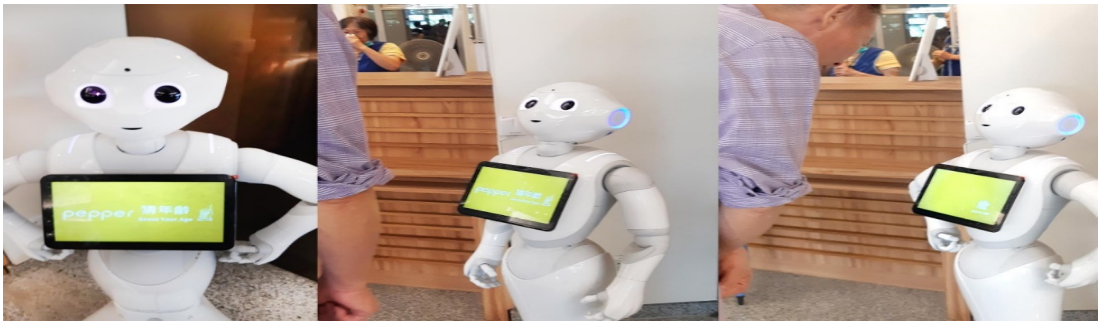

Figure 3. Interaction process of Pepper robot to recognize user's age by the human face

(6) Primitive fascination factors—Interface Design (15%)：The interface is designed that mainly using images for interaction. It tries to avoid too many text descriptions. Moreover, the buttons on the interface are quite large, so it is easy for the elderly to recognize and operate.

(7) Primitive fascination factors—Voice Service (5%)：Oral explanation is combined with interface imagine. The user can operate the panel and hear the voice instruction at the same time. Multiple levels of information can accelerate the registration process.

4-2 Concrete fascination factors and abstract fascination factors attract users to operate

In this study, the Evaluation Grid Method was used to interview the subjects to gain a deeper understanding of the attractiveness factors, concrete fascination factors, and abstract fascination factors of their primitive fascination factors as shown in Table 2.

Table 2. The Evaluation Grid Method is used to compile the appeal of Pepper robots

NO	attractiveness factors (primitive fascination factors)	concrete fascination factors	abstract fascination factors
1	Environment 5%	Robot placement site	Interactivity, Entertainment
2	Time 10%	The user's schedule for the day. No queuing operation.	Vacant, convenient, interactive
3	Appearance 20%、	Robot overall shape, non-simulation of human appearance, robot height	Interactive, attractive, pleasing, affectionate, affable, stress-free, oppressive, novel, interactive, unique, intimate, special, attractive, cute, affectionate
4	Function 35%	Text description type registration, image recognition type registration, registration speed, map navigation	Simple, fast, convenient, interactive, clear, no delays
5	Game 10%	Age guessing games, game styles	Fun, interactive, curious, special
6	Interface Design 15%	Operation flow, graphic design	Simple, aesthetically pleasing, thoughtful, design-oriented, simplified, convenient, easy to identify, and not easily readable
7	Voice Service 5%	Operation instruction	Convenience

5. Conclusion

5-1 Research Conclusion

In this study, the Evaluation Grid Method was used to study the most important attractiveness factors which are Environment 5%, Time 10%, Appearance 20%, Function 35%, Game 10%, Interface Design 15%, and Voice Service 5%. Pepper service robots are used in medical institutions to assist with outpatient registration, in-hospital navigation, problem consultation, and entertainment games. The robots let the patients and the hospital getting closer and also release the workload of the health caretakers and volunteers.

5-2 Future Research Proposals

In addition to the effectiveness of Pepper's service robot, users also gave other suggestions for the future design, which are summarized below:

1 Barrier-free design: Implementing the blind-guide interface, such as guiding the visually impaired friends to the reception room for further assistance. The panel must equip with multiple barrier-free functions to serve

a wider range of user groups.

2 Appearance：Users think Pepper's appearance is too high-tech, making it is not easy to get close to. With furry skin or a round shape, it will make it more attractive. Moreover, if the Peppers could speak like a human, i.e having the mouse move while talking, it will be more attractive.

3 Direct Instruction：Instead of showing the map in detail. It would more straightforward that the robot can directly lead people to the destination.

4 Voice Recognition：Adding 3D bottoms control to have an easy operation for the visually impaired or the elderly.

5 Multilingual：Users suggest that it should have a multilingual voice recognition function for fitting the various regional language or uneducated.

6 Medical Games：It is suggested to develop medical-related games for delivering medical knowledge, such as the game of measuring body fat, explaining how to prevent cardiovascular diseases.

7 Time limit：It is necessary to limit time for each user in operating the robot to avoid over-occupancy, causing others to queue for too long and lose their patience.

In this study, we used the evaluation grid method to analyze the impact and demand of service-oriented robots on medical institutions. The results can provide a reference for the future development of service-oriented robots and the related fields.

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