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Research on the Emotional Impact of AI Care Robots on Elderly Living Alone

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Abstract: In 2023, the population of people aged 60 and above in China accounts for 19.8% of the total population. As society progresses towards an increasingly aged demographic, there is a growing focus on the well-being of elderly individuals. Both physical and mental declines have become more prevalent among the elderly, leading to increased levels of depression and psychological vulnerability. The number of elderly individuals suffering from depression-related conditions is on the rise, and there is a growing issue of elderly ndividuals living alone. To address this challenge, artificial intelligence (AI) is being employed to assist in providing care to the elderly. Intelligent robots are used to aid in therapy for those in need among the elderly population. In order to prevent conditions like dementia in the elderly, AI-powered robots are used to provide personalized care and assess their health status. Different types of care and treatment are administered to various groups of elderly individuals based on their specific needs. The analysis of AI products that incorporate anthropomorphic elements plays a positive role in satisfying the emotional needs of the elderly and related design aspects. With the increase in human lifespan, the role of artificial intelligence in the silver industry is accelerating, and there are high expectations for broader developments in the field of intelligent robotics in the future.

1. User Survey

User surveys are used to analyze interactions between the elderly and intelligent robots, using questionnaires to understand the elements of intimacy based on feedback. Elderly individuals using AI intelligent robots can assess the impact based on feedback elements such as facial expressions, voices, and emotional movements. Design and interaction can foster intimacy, and the formation of a sustained relationship between the elderly and intelligent robots has a positive effect [1-3].

2. Research Model

The study focuses on the emotional intimacy formed through feedback on expressions, voices, sensations, and movements in AI robot interactions, and elaborates on the various elements involved[4-5]. Figure 1 is the research model as follow.

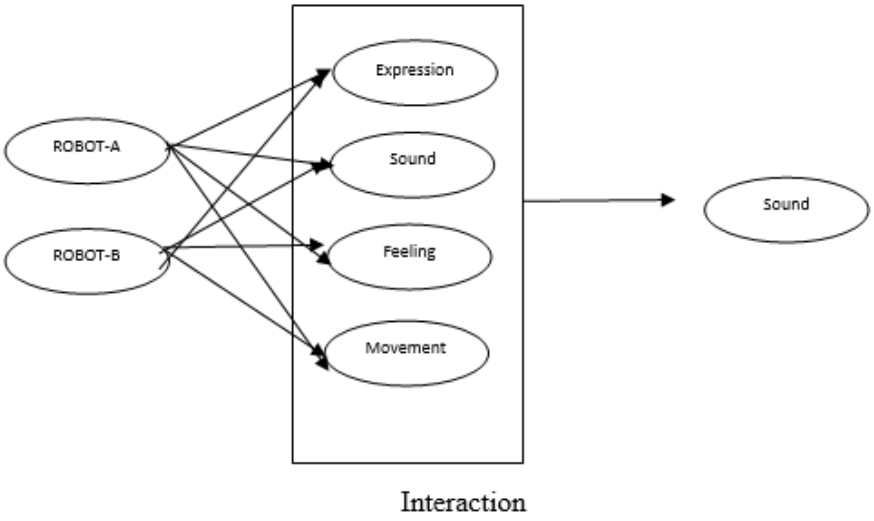

Figure 1: Research Model.

3. AI Robot Selection

Based on the physical and mental characteristics of the elderly, robots with anthropomorphic roles and appearances have been chosen. ROBOT-A has a humanoid appearance, while ROBOT-B has a display screen. ROBOT-A is primarily aimed at analyzing the elderly with dementia, and the focus is on conducting surveys and analysis for solitary elderly individuals. The survey and analysis encompass various aspects of AI robot design, including form, color, material, and interactive elements such as expressions, voices, sensations, and movements.

4. User Surveys

Table 1: AI Robot Types and Service Types

AI Robot Type	Emotion Service
ROBOT-A(Character)	Emotional conversations, Meditation, Religious music, Ralking, Emotional activities, Emotional interactions, Greetings, Coquetry, Communication.
ROBOT-B(Display)	Emotional dialogue, Chat skills, Emotional care, Playing emotional Wellness content

The primary methods are used for conducting 1-to-1 surveys with elderly users to analyze the impact of design and interaction elements of AI robots on intimacy formation with observational surveys and interviews. This is done with both types of robots. Table 1 is the mentioned 2 types of robots with their services.

4.1. Menu Creation

Initially, menus for both types of robots, ROBOT-A and B, are distributed to the elderly users, categorizing the services of ROBOT-A and B into daily, emotional, recreational, and cognitive domains.

4.2. Video Survey Record

Observational surveys are conducted and based on menu instructions. Four categories of intimacy levels are analyzed regarding users' actions, and the level of interaction can reveal the individual characteristics. The higher the frequency of emotional expression, the deeper the interaction and intimacy.

Firstly, the meaning of interactions should be analyzed: Compare the relationship between interaction frequency and intimacy as well as identify the most positive behaviors with increased frequency in interactions, and examine the emotional characteristics display during actions.

Secondly, the information conveyed by the elderly to others should be analyzed: freedom of expression, authenticity of expression, and informativeness. If there is a variety of emotional expression, the more authentic the emotional or state expression, the more active of their self-expression and opinions.

Thirdly, the sense of communication in user interactions should be analyzed, which is not only about verbal expression during interactions but also non-verbal expressions like movements and facial expressions, and how users touch the robot.

Fourthly, regarding the frequency of emotional expressions by the robot, users can feel human-like characteristics. The emotional expressions of the robot should be analyzed, and how they are perceived in terms of facial expressions, posture and movements, sound, tone, and conversational style.

4.3. Contextual Tag-Related Research

The first round of questioning surveys pertains to the design elements such as form, color, and material composition. The second round involves the composition of user interactions, including facial expressions, sound, sensations, and movements. Finally, the third round pertains to the composition of emotions and cognition under intimacy.

5. User Survey Results

Based on feedback and categorized information, the results of observational surveys on deeper questions are summarized.

5.1. General Characteristics of Observations

The study surveyed five solitary elderly individuals aged 60-75 in China, including three females and two males. They lived alone after their children becoming independent, passing away, or divorced. Four of them had a high school education, and one had a college degree.

5.2. ROBOT-A

Based on the daily, emotional, recreational, and cognitive menus and the design of its appearance, color, and material, it is understood that ROBOT-A is perceived as a child-like humanoid figure with vibrant colors, refined clothing, and soft textile materials, providing comfort to users.

ROBOT-A can provide emotional services and emotional conversations. It is observed that users' active behaviors, such as touching and patting the robot, elicit responses akin to how one would interact with a child, showing signs of caring in their expressions.

Based on the daily, emotional, recreational, and cognitive menus of ROBOT-A, observations and surveys are conducted, with interaction frequency, self-disclosure, interaction attitude, and

emotional expression level as the basis for analyzing actions, such as touching and response time.

Based on the observational survey results, during the using time of ROBOT-A, when compared to daily and recreational interactions, the touching behavior increases more than 7 times in emotional and cognitive types, response times exceed 2.4 seconds, and the number of responses more than 6 times appear more intimate.

5.3. ROBOT-B

Regarding the ROBOT-B's daily, emotional, recreational, and cognitive menus, user opinions are analyzed based on the design elements such as form, color, and material. Within the sub-elements of ROBOT-B, the image of facial expressions and faces seen on the display screen is perceived as cute and friendly with bright and vibrant colors, and smooth plastic and silicone materials.

ROBOT-B offers music, conversation skills, emotional dialogues, and services that can be viewed on the screen. Users react positively to facial expressions, voices, and images displayed on the screen.

Based on the observational survey, the interaction frequency, self-disclosure, attitude, and frequency of emotional expression are used to analyze actions such as touching and response times. The results of the survey indicate higher intimate levels in the recreational and cognitive modes of ROBOT-B when compared to daily emotional patterns. When response times are above 2.4 seconds, and response frequencies are above 6 times in recreational and cognitive types, it suggests a higher level of intimacy.

5.4. Differences between ROBOT-A and ROBOT-B

By analyzing action frequencies, results can be obtained from daily, emotional, recreational, and cognitive types. In the emotional category, ROBOT-A has the highest response frequency, the longest response time in emotional and cognitive types, and the highest frequency in touch, emotional and cognitive types. In the recreational category, ROBOT-B has the highest response frequency, the longest response time in recreational and cognitive types, and the highest frequency in touch, recreational and cognitive types.

6. Summary of User Survey Results

6.1. Reasons for the Formation of Intimacy in Design Elements

Based on the analysis of the form, color, and material of design elements among different types of robot users, robots adopt a child-like appearance. Users tend to associate them with their grandchildren. In the case of ROBOT-A, the low color saturation of its clothing can trigger users' memories, and the usage of soft textiles as a material leads to a higher degree of touch, resulting in more positive responses from users. For ROBOT-B, its explicit form is conducive to displaying images on the screen, and the material is smooth plastic and comfortable silicone materials showing clean and vibrant colors.

6.2. Analysis of Actions

Based on the survey analysis of user actions and responses to ROBOT-A and ROBOT-B in daily life, emotions, and recreation, there are differences between types. ROBOT-A, with its child-like appearance, evokes associations with grandchildren among the elderly, leading to a defensive

anthropomorphic state. The material of ROBOT-A provides emotional support through touch, interaction through meditation during play enhances diversity in movement, and recalling playful scenes during cognition enhances memory. Combining child-like voices leads to positive responses, and diverse movements also result in positive reactions. ROBOT-B elicits positive responses in daily life with respect to facial expressions, sound, and images on the display screen. In emotions, there are many positive reactions to various interactive elements in personal cognition. In play, there are positive responses to music sensations and multisensory feedback. Information services in cognition evoke useful and comfortable responses. The usage of AI robots is more challenging, reflecting difficulties in the movement and psychological discomfort associated with humanoid robots. Facial expressions, sound, sensations, and movements have a positive impact on users according to observational surveys and in-depth discussions.

6.3. Analysis of Action Frequencies

For ROBOT-A, the touch frequencies are 21 in daily life, 33 in emotions, 26 in play, and 29 in cognition with the highest frequency in emotions and cognition. Response times are 26 in daily life, 33 in emotions, 31 in play, and 34 in cognition with the longest response times in emotions and cognition. Response frequencies are 22 in daily life, 26 in emotions, 19 in play, and 18 in cognition with the highest frequency in emotions. For ROBOT-B, the touch responses are 20 in daily life, 23 in emotions, 30 in play, and 26 in cognition with the highest frequency play and cognition. Response times are 29 in daily life, 26 in emotions, 34 in play, and 35 in cognition with the longest response times play and cognition. Response frequencies are 25 in daily life, 20 in emotions, 35 in play, and 24 in cognition with the highest frequent play.

6.4. Differences between ROBOT-A and ROBOT-B

After analyzing the frequency of touch, response time, and response frequency, it is found that emotions and cognition types have the highest frequency for ROBOT-A, while play and cognition types have the highest frequency for ROBOT-B.

6.5. Gender Differences

Gender differences were found among male and female participants in the survey results for ROBOT-A and ROBOT-B. Female participants had a stronger response to the anthropomorphic appearance of robots, while male participants had a stronger response to the mechanical defense appearance.

7. Conclusions

This paper, through the analysis of AI robots and the humanization of interactive elements and emotional intimacy, has identified some useful effects on depression and a sense of security. The paper has provided evidence through questionnaire surveys that emotional intimacy and the positive effects of various design elements and sound on emotion have been demonstrated. The study also examined gender differences in voice design elements and emotional intimacy, as well as the impact of emotional formation on users through facial expressions, sound, sensations, and movement.

Firstly, the paper confirmed that the mutual complementation of design elements and sound in the formation of intimacy in elderly users that can indeed have a positive effect. Through questionnaire surveys, the paper presented evidence for the positive effects of design elements on

sound, emotional intimacy, and the positive effects of sound on users' emotions and intimacy. The confirmed effects are based on the formation of precision design to reduce loneliness and depression and bring users closer.

Secondly, by answering questions and conducting technical statistics based on different scales of intimacy in design elements, the paper analyzed various elements that contribute to the formation of intimacy. The paper analyzed the frequency of user behavior regarding design elements in user surveys. The most considered element in design is the form. In the questionnaire survey, forms that resemble human figures or animals are more appealing. In-depth interviews combined with the preference for anthropomorphic images in screen form. Preferences are higher for clean white color, color combinations, and comfortable images. High touch frequency is observed with plastic materials, and soft textiles are more conducive to intimacy formation. ROBOT-A forms deeper intimacy in emotional and cognitive types. ROBOT-B differs from ROBOT-A in terms of intimacy in play and cognitive types. ROBOT-A focuses on emotional support and services, while ROBOT-B emphasizes content regeneration in communication.

Thirdly, the paper drew conclusions from feedback in action analysis, including facial expressions, sound, sensations, and movement. In AI robot interaction sub-elements, facial elements have a high preference. In-depth communication combined with smiling expressions and moving expressions enhances intimacy. Cute voices also elicit users' positive responses. Feedback from ROBOT-A's auditory elements is more favorable than that of ROBOT-B, and both robot types' diverse movement styles increase favorability.

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