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Intelligent Medical App Design for Parkinson's Disease Based on Augmented Reality Technique

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Abstract. Based on the theory of augmented reality technology, this article proposes the design method of follow-up practice for Parkinson's disease patients' daily management difficulties and inconvenient exercise medical treatment, and through the design practice, the intelligent medical app for Parkinson's disease is created. The article mixes AR (augmented reality) technology to provide Parkinson's disease sufferers with a clearer, more scientific, and more entertaining medical training experience. By merging multiple medical resources and augmented reality teaching methods, it eliminates the pain spots in sports medical and daily management procedures through intelligent approaches, thereby motivating and directing patients to confront life optimistically. Through expert and user validation, it was demonstrated that this product can improve the experience of patients in sports medical care and effectively enhance the emotional stability of patients, thereby providing design ideas for the future development of daily management methods for elderly people with limited mobility.

Keywords: Telemedicine; Parkinson's disease; medical training; interview survey

1. Introduction

Parkinson's disease (PD) is the second most common neurodegenerative disorder after Alzheimer's disease [1,2], characterized by disruption of various neurotransmitter pathways in the brain and autonomic nervous system. As China's population ages, Parkinson's disease has become the fastest-growing neurological disease in terms of incidence and is becoming increasingly physically and emotionally damaging to the elderly. According to the National Center for the Prevention and Control of Chronic and Non-Communicable Diseases, the prevalence of Parkinson's disease in China is 1.37 percent among senior persons aged 60 years and 1.63 percent among those aged 65 years, with an estimated 3.62 million cases [3]. China will account for fifty percent of all Parkinson's disease sufferers worldwide by 2030 [4]. The lives of Parkinson's patients and their families are fraught with challenges, and we urgently require clever rehabilitation tools built specifically for the Parkinson's patient community.

To meet the demand for training medical therapy for people with Parkinson's syndrome, we must create an intelligent medical assistance for Parkinson's disease patients by merging clever current medical treatment with intelligent medical help. We expect that this would minimize the difficulty of independent living and assist patients in regaining their self-respect and optimism for the future. Under the method for providing safety protection and health care, the patient and the caregiver are granted relative independence through intelligent medical therapy.

2. Literature·Review

2.1 Characteristics of Parkinson's Disease and Patients, Current Status of Scholars' Research

2.1.1 Parkinson's disease and patient characteristics

Parkinson's disease is a prevalent neurodegenerative condition of middle-aged and older individuals characterized by motor bradycardia, myotonia, and resting tremor. The development of Parkinson's disease often occurs between middle age and old age, and research suggests that the primary pathophysiology is the inability to manufacture sufficient dopamine following the

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degeneration and death of cells in the substantia nigra of the midbrain. Muscle stiffness, motor slowness, resting tremor, depression, and other symptoms occur when the amount of dopamine production is insufficient. Parkinson's disease is manifested clinically by resting tremor, muscle rigidity, gait and postural abnormalities, and bradykinesia. Bradykinesia is one of the primary symptoms, and individuals may move more slowly with time. In the middle and late stages of Parkinson's disease, non-motor symptoms (such as depression, constipation, sleep difficulties, cognitive impairment, etc.) can have a significant impact on patients' quality of life [5].

2.1.2 Current status of scholarly research

Xiao Yisheng et al. concluded that Parkinson's disease is highly prone to anxiety and that Parkinson's patients are prone to low depressive moods accompanied by self-blame for their disease and loss of life due to their diminished ability to care for themselves and increased burden on their families [6]. M. Macht et al. examined a sample of 3075 patients to evaluate the frequency of psychological problems and used cross-validated cluster analysis to discover the pattern of these issues. During the illness, symptoms increased by 68%, sleep disruptions increased by 32%, and sexual problems increased by 57% and 22% in men and women, respectively. Less common were communication issues (27%), the need for assistance from others (38%) and sad mood (20%). There have been recognized four patterns of psychological issues: general low stress, general high stress, sexual and social problems, and non-social problems [7].At the same time, the patient's illness frustrates his or her self-worth and self-esteem to varying degrees, which makes the patient extra sensitive, and once this need for self-esteem is ignored, it is highly likely to shake the patient's confidence in treatment and trust in health care professionals, making recovery less efficient.

In terms of treatment, the majority of experts agree that the principle of Parkinson's disease treatment is to address dopamine deficiency, and that levodopa replacement therapy is typically the primary treatment, along with exercise and rehabilitation therapy, psychological intervention, and nursing care [5]. Currently, the treatments for Parkinson's disease are generally well-developed and may be categorized into three basic categories: medication, rehabilitation training, and surgical therapy. In the early stages of Parkinson's disease, medication with daily rehabilitation training is used to alleviate the disease; only when the disease progresses to the middle and late stages, the effect of medication diminishes, or more severe disease develops is surgical therapy used to alleviate the disease. It is essential to remember, however, that Parkinson's disease cannot be cured and can only be treated with medicine and daily exercise.

Regarding daily rehabilitation, Wang Qiaohong and other researchers utilized follow-up observations to understand the changes in the patient's condition and the rehabilitation process in order to improve the management of the patient's disease risk factors and increase the patient's awareness of self-management. After the condition has remitted, it can cut medical costs and conserve medical resources [8]. In the field of exercise medicine, Dani Caroline and colleagues focused more on the use of exercise therapy to regulate oxidative stress in the patient [9]; they verified through a comparative experimental approach that water exercise can regulate oxidative stress, thereby achieving a balance between the production of reactive oxygen species and the body's antioxidant defense capacity, which can more effectively alleviate the problem of physical function decline in Parkinson's disease.

Our academics specialize on the clinical treatment of Parkinson's disease while creating Chinese medicine drug treatment methodologies. However, little study has been undertaken on the psychological and motor rehabilitation levels of patients on a daily basis, and fewer researchers have utilized the Internet+medicine strategy to solve the problem. The purpose of this study is to construct an intelligent augmented reality-based rehabilitation software for Parkinson's disease, which is committed to the integration of telemedicine, patients, and patients' families into healthcare.

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2.2 Overview of Theories Related to Augmented Reality + Healthcare (Advantages of Augmented Reality Telemedicine)

Definition of augmented reality technology: AR technology is a technology that interactively merges the virtual world with the real world, presenting virtual information to the user after augmenting the real scene in order to improve the user's perception and interaction with the real world [10]. There are two authoritative definitions of augmented reality (AR) technology: the first is the concept of "reality-virtual continuum" proposed by Milgram and Kishino [11] in 1994, which classifies the display environment combining virtual and real, and the real and virtual environments are distributed at the two ends, the one closest to the real environment is the real environment, and the one farthest from the real environment is the virtual environment. The real environment and the virtual environment are dispersed at the two ends, with augmented reality near the real environment and virtual reality near the virtual environment, and mixed reality in the middle. The second definition was proposed by Azuma [10] in 1997, who believed that augmented reality technology should have three characteristics: I virtual-reality combination, which combines real and virtual information in a real environment; (ii) real-time interaction; and (iii) three-dimensional registration, which enables the integration of real scenes and virtual information.

The convergence of augmented reality and medical care: In the context of the post-epidemic period, telemedicine models such as "augmented reality + medical care" have emerged as the new approach for the advancement of medicine. The Internet (augmented reality, etc.) + medical model is unquestionably the best option for patients with mild conditions or those who require continuous treatment. Telemedicine based on mobile Internet can not only alleviate the burden of community epidemic prevention, but also provide patients with the convenience of quick access to medical treatment at home.

2.3 Current Research Status and Specific Applications of Augmented Reality + Healthcare

Visual augmented reality Visual augmented reality technology is the most prevalent training method, which is frequently coupled with occupational therapy and mirror therapy in rehabilitation training [12]. Mousavi et al. [13] developed an AR-based vision-based rehabilitation system. During therapy, the patient sits at a treatment table, the projection-based display projects a virtual background onto the treatment table, and the patient utilizes actual objects to interact with the virtual world.

Haptic augmented reality technology Haptic Augmented Reality technology is the addition of haptic feedback to conventional AR technology, which can effectively increase sensory feedback during patient training and strengthen the connection between peripheral environment and central control, which is more beneficial for patients with both sensory and motor dysfunction [12]. Luo et al. [14] designed a rehabilitation system that integrates AR and pressure assistive devices; the system's assistive devices are AR and pressure assistive devices. The system evaluates if the patient's hand is in the correct position while the patient wears the assistive device for gripping virtual objects, and the device creates a certain level of pressure to assist the patient in grabbing the object. The findings of a box test designed to evaluate a stroke patient's upper extremity function after 6 weeks of training with the system revealed that the system considerably improved the patient's hand grip.

Mirror augmented reality technique Initially used to decrease phantom limb discomfort after amputation, mirror treatment has become more prevalent in the functional rehabilitation of the upper limb in stroke [12] in recent years. Assis et al. [15] created a rehabilitation system (NeuroR) in which the user sees a mirror image of their upper limb on a screen, simulates the paralyzed arm with a virtual arm, and completes the required activities by manipulating the uninjured arm and the hemiplegic arm. Eight stroke patients participated in the trial and were randomly assigned to either the treatment group (rehabilitation using NeuroR) or the control group (no treatment) (conventional rehabilitation).

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3. Reality-Based Patient Medical Training Model Design

In order to identify commonalities among individuals with Parkinson's disease, the author used questionnaires and interviews to study and evaluate the family situations and self-management skills of the interviewees. Chen Wenxiu and other researchers [16] categorized the self-management content of Parkinson's disease patients into the following five categories: medical monitoring, self-monitoring, exercise management, emotional management and daily life management. The author increased the proportion of questions in the questionnaire and interview pertaining to exercise management (about 28%) and emotion management (approximately 28%).

3.1 User Needs Research

3.1.1 Research plan and questionnaire setting

In September 2022, questionnaires were distributed and patients were questioned at the university hospital following the creation of the questionnaires and interview plan. With the assent of the patients, data collection and analysis were conducted; 120 questionnaires were distributed and 120 were collected, for a recovery rate of 100%; 116 were valid, for an efficiency rate of 96.7%. In addition, a sample of patients who completed the questionnaires were interviewed, and ten interviews were done, of which ten were valid, yielding a 100% efficiency rate.

3.1.2 Research results and analysis

Patients' essential information: The youngest patient in this study was 46 years old and the oldest was 86 years old, resulting in a 40-year age range and a mean age of 62.7 years, with 49.1% of patients over 60 years old and 50.9% of patients under 60 years old. Sixty-seven percent of the 78 cases had a college degree or higher. In terms of family status, 102 cases (87.9%) were married, and 96 cases (94.1%) were living with their spouses. Refer to Table for information.

Patient self-management capacity assessment:The study's findings revealed that the self-management ability scores of 116 Parkinson's disease patients ranged from 32 to 91, with a mean score of 51.9. The average score of the medical monitoring module was 10.4 (total module score of 16; approximately 65%), the average score of the self-monitoring module was 7.3 (total module score of 12; approximately 60.8%), the average score of the motor management module was 9.1 (total module score of 28; approximately 32.5%), the average score of the emotional management module was 13.9 (total module score of 28; approximately 49.6%), and the average score of the daily life management module is 11.2 (to

Overall, the self-management ability of the surveyed patients was close to the expected passing level of 60%; the frequency of medical monitoring and self-monitoring ability of the surveyed patients reached the expected passing level of 60%, indicating that the patients were more aware of and attached more importance to their conditions (likely due to the hospital research environment); the highest percentage of daily life management ability of the surveyed patients was 80%. The highest percentage of patients' ability to manage their daily life indicates that the majority of patients are confident in their ability to manage their daily life; it is important to note that the scores of patients' ability to manage their emotions and exercise are low, indicating that the primary treatment mode of the interviewed group is medication and they do not pay sufficient attention to exercise treatment mode.

In conclusion, according to the assessment of the questionnaire, the majority of Parkinson's disease patients in China have a moderate degree of self-management capacity, with the exception of exercise management and emotion management, which are at a low level. In China, Parkinson's disease is currently treated mostly with medications (Chinese medicine, etc.), with less emphasis placed on the daily exercise treatment of patients.

3.1.3 Pain point collection

6 patients mentioned not knowing how to perform scientific motor rehabilitation, 5 patients mentioned a tendency toward speech and pronunciation disorders, 7 patients mentioned poor sleep

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quality and emotional instability, and 3 patients' family members in the middle and late stages of the disease mentioned cognitive impairment similar to Alzheimer's disease. Seven patients indicated "poor sleep quality and emotional instability," while three family members of patients in the middle and late stages of the condition mentioned "cognitive impairment, similar to that of Alzheimer's disease."

From their descriptions, we can derive the following five kinds of pain points: a lack of comprehension of exercise therapy, a tendency toward speech and pronunciation abnormalities, sleep and mood issues, cognitive impairment prevention, and a loss of life interest.

3.2 Mapping of User Requirements to Design Points

3.2.1 No understanding of exercise therapy methods → AR visualization exercise training guidelines

In the treatment of Parkinson's disease, exercise training therapy is one of the most significant daily tools, and combining exercise therapy with medicine is an effective method for reducing symptoms. However, research indicates that Chinese patients rely more on medication to alleviate their symptoms than on exercise training, or that they are unaware of effective exercise training techniques. Existing exercise apps for Parkinson's disease and other conditions typically use videos to guide patients, but, according to interviews, this teaching method is less effective, patients frequently have difficulty concentrating on learning the precise movements, and watching and learning is inconvenient. Patients lose motivation to study and train and pay less attention to exercise training over time.

We must employ augmented reality to accurately guide the movements in training and to synchronize the detection and feedback of patients' movements, so that patients have a positive experience and are more interested in sports training.

3.2.2 Tendency to have speech dysarthria → Speech dialogue module guides breathing training

Parkinson's disease patients commonly present with hypokinetic dysarthria. 75% to 90% of Parkinson's disease patients suffer from speech impairment, although only 3% to 4% of individuals get treated [17]. Breathing, vocalization, and diction training can be utilized to help people with dysarthria reduce their symptoms and enhance their swallowing capacity.

The author intends to add a voice conversation module to the app and supporting items in order to communicate with patients at predefined times each day and coach them through vocal cord and laryngotracheal function training.

3.2.3 Sleep and mood problems → Light music and exercise therapy to improve sleep, AR social module to stabilize mood

Parkinson's disease is frequently accompanied by anxiety and depression, and these conditions significantly impair patients' ability to sleep and connect with their emotions.

Several studies have demonstrated that moderate-intensity fitness exercises can effectively improve the sleep quality of Parkinson's disease patients, and traditional Chinese fitness methods, such as five-animal play, are moderate in intensity and popular among middle-aged and elderly patients, which have a positive effect on sleep disorders in Parkinson's disease patients [18]. software with the intention of combining exercise therapy, such as five-animal play, with light music, while employing augmented reality to rapidly coach patients through the practice for the best therapeutic effect.

While patients improve their sleep, the author wished to integrate social factors to strengthen their training and learning motivation. AR presentation can mark the virtual picture of the surrounding users, and patients can clock in and submit to the regional list after finishing the training, as well as converse and encourage each other with other users during their free time. This project can enrich the spiritual lives of patients to increase their interest in life and decrease their stress levels.

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3.2.4 Cognitive impairment prevention → AR gamification cognitive training

Cognitive impairment is a major non-motor symptom that mostly affects the executive functions, attention, planning, working memory, visual perception, object identification, and learning of patients [19,20]. This symptom is relatively common in Parkinson's disease, and the severe stage may potentially progress to dementia, which will place a significant burden on patients and their family. Therefore, the app must incorporate the avoidance of cognitive damage.

In the app system, the patient will be able to identify common "models" of the five senses observed by the patient and on the internet for cognitive training; and set up cognitive games that imitate real-life circumstances to increase the patient's capacity to care for themselves. The AR cognitive game is conducted daily at a specified time, and the patient's cognitive status is evaluated based on the score and physical status of each game. The records are then submitted to the patient's family and hospital in order to determine the expected cognitive level for the following game.

3.2.5 Lack of interest in life → AR regional cultural elements

The loss of interest in life is one of the most significant issues that makes it difficult for Parkinson's patients to adhere to their training, and the high psychological and physical burden makes it challenging for them to engage with new things.

Travel is one of the most important ways for young people to unwind, so we hope to incorporate the concept of "spiritual travel" into the daily medical care of Parkinson's patients, and incorporate the cultural elements of each region into the augmented reality scenes, so that patients' training and lives are less monotonous. This is also one of the fundamental principles included in every function.

3.3 Interpretation of Design Models in User Medical Training

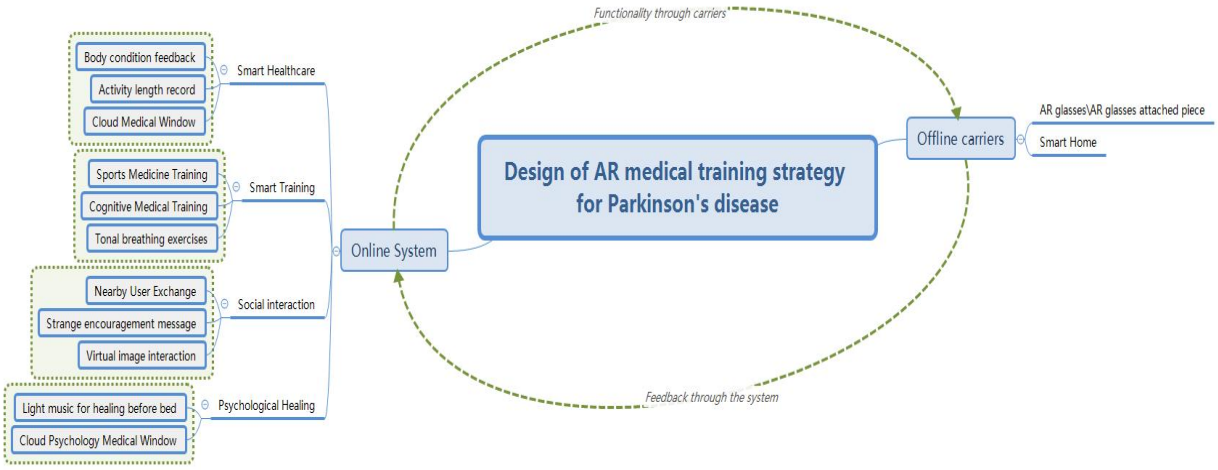

Figure 1

3.3.1 Online system

It is divided into four sections: Smart Medical, Smart Training, Social Interaction, and Psychological Healing. The first two modules are primarily designed for the user's condition and various types of training and learning; they are the product's key functional modules. The last two modules are primarily designed for the user's daily life and psychological condition in order to improve the user's emotional stability; they are the product's daily support modules.

3.3.2 Smart Medical

Through the cloud and the hospital terminal for interconnection, the user's physical condition is tested at a fixed time every day, and the user's activity time using the product is recorded and

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dynamically analyzed, and the results are fed back to the user and his family through AR, and a training and learning plan tailored to his daily condition is generated.

Establish a cloud-based medical window in the event that the patient's status is uncertain in order to keep timely communication with the doctor and to reduce hospital back-and-forth or delays in treatment.

3.3.3 Intelligent training

The training consists of three forms of training: motor, cognitive, and composition breathing. Plans for the three categories of training are produced by a cloud-based doctor based on the user's physical condition evaluation. This technology employs AR to show information so that crucial information points can be given more accurately, hence eliminating the previous inconvenience of having to view the movie multiple times.

3.3.4 Social interaction

In the social module, the system will generate a virtual image in the AR interface based on user preferences, and users will be able to interact and communicate with nearby users via this image in the AR device, which not only protects users' private information but also makes their training more enjoyable.

A function like "message drifting bottle" has been added to the social AR interface. When the system detects that the user's mood and training score are fast deteriorating, it will immediately alter the user's study plan and provide them with motivational comments from strangers.

3.3.5 Psychological healing.

Establish a bedtime music healing portion and a cloud psychological medical section, with the former accountable for users' daily issues such as sleep and emotions, and the latter for cumulative and abrupt psychological difficulties (such as depression, anxiety, etc.).

3.3.6 Environment and safety.

Patients with Parkinson's disease are frequently accompanied with postural reflex problems; these patients have a poor sense of their own center of gravity and body posture, walk with an unstable gait, and are prone to falling [21]. Therefore, it is best to design the area where patients move in a targeted manner, such as by adding handrails and rubber pads within an appropriate height range. In addition, to prevent users from being injured when using AR (augmented reality) devices, the system will define a safety range based on the space's layout, and if the user exceeds this range, the device will immediately halt the interface display and deliver a vibration alert.

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3.4 Design Development

3.4.1 Main Interface

Figure 2

Figure 3

3.4.2 Matching product design drawings

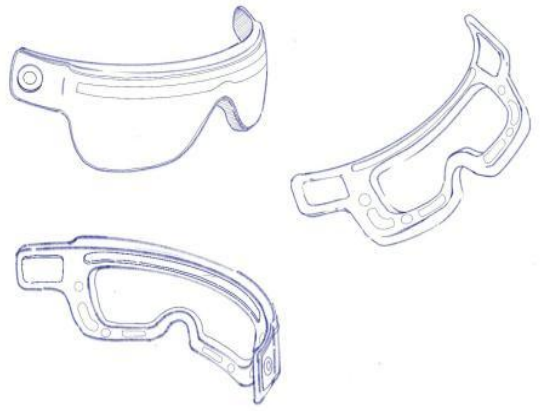

Figure 4

Figure 5

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3.4.3 Matching products effect picture

Figure 6

3.5 Experimental Verification

After completing the APP, the author disseminated a product usability test questionnaire through interviews. Since the majority of patients were middle-aged or elderly, we collected replies and scores using a question-and-answer interview approach. The questionnaire's content was roughly divided into three pieces.

1) Information collection

2) Difficulty and information interface

a) The ease of using APP

b) App information interface rating

3) APP feature expectation rating

The second panel consisted of twelve questions, each from one to seven points, for a total of eighty-four points. There were five questions regarding the app's usability, totaling 35 points, and seven questions regarding the app's information interface, totaling 49 points.

After interviewing 12 seniors (66.7% of respondents were older than 55), we obtained their responses.

In the sections of difficulty and information interface, the first part of the answers regarding the difficulty of using the APP received a total of 362 points (out of 420 total points), which is equivalent to 86.2% of the total score; the second part of the answers regarding the information interface of the APP received a total of 468 points (out of 588 total points), which is equivalent to 79.6% of the total score. Both grades are approximately 80%, indicating a high level of product feasibility.

In the APP feature expectation rating section, the feature with the highest expectation rating is "using innovative training methods combining modern and traditional culture, such as 'Five Animal Play,'" with a score of 51 (total score of 60), accounting for 85% of the total score; the feature with the lowest expectation rating is "using virtual exercises," accounting for 85% of the total score. The function with the lowest expectations is "social interaction with nearby users through virtual image," with a score of 42 (out of 60), or 70% of the total score;It can be seen that the elderly people are more receptive to the function of exercise training combined with traditional culture, and gain more positive comments. It is worth noting that middle-aged and elderly patients are not opposed to the use of AR technology, but are more interested in it than we anticipated.

After gathering user feedback, we decided to revamp the social section. This strategy could boost the intimacy and familiarity of the user images by substituting virtual images with cartoons of regional and cultural components common to middle-aged and senior individuals (e.g., hot pot, mahjong, etc.). After testing, patients of middle age and older were more open to the new image.

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4. Summary

4.1 Advantages and Limitations

In the context of the 5G age, telemedicine can not only eliminate the physical and temporal barriers between patients and hospitals, but it also has a significant impact on individuals with limited mobility. This App and its related goods are a daily tool for people with Parkinson's disease that can help them live a healthy, enjoyable life, and can also serve as a social companion, providing patients the confidence to live and exercise independently. In addition, the availability of this APP helps alleviate the emotional and daily burdens of patients' family.However, due to the usage of cutting-edge technologies such as augmented reality, patients may require some time to acclimatize. In addition, the application must be tested on a small scale prior to full installation.

4.2 Future Outlook

It is envisaged that the Parkinson's Disease Smart Medical App can be integrated with community activity centers, community hospitals, and other public spaces in order to combine augmented reality medical care with offline medical treatment. It enables patients to not only walk around at home, but also to obtain improved training assistance so that the training program can be more personalized to the patient's condition and also to seek a path for Parkinson's disease rehabilitation.

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