DDA-SVM: A Dynamic Difficulty Adjustment SVM Model for Electronic Cognitive Training Games

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***Abstract*—This study proposes the DDA-SVM model, which uses Support Vector Machine (SVM) for Dynamic Difficulty Adjustment (DDA) to enhance electronic cognitive training games aimed at preventing and delaying dementia. The study involved participants with dementia of varying severity. The results showed that after implementing the DDA-SVM model, 41.94% of the participants experienced a decline in the severity of dementia, while 58.06% of participants maintained their initial level. Moreover, DDA-SVM significantly preserves participants' cognitive function over time, as compared to the testing process without its implementation. In conclusion, the contribution of the DDA-SVM model lies in introducing electronic cognitive training games, thereby significantly improving their effectiveness. To further validate and enhance the DDA-SVM model, future research should consider expanding the sample size and extending the study period.**

Keywords—DDA-SVM model, SVM, DDA, electronic cognitive training games; preventing and delaying dementia.

I. Introduction

Dementia is a degenerative disease that affects patients' social relationships and functional abilities. According to Kao et al. [1], the prevalence of all-cause dementia ranges from 83.3% to 87.4% in various facilities, which emphasizing the importance of preventing and delaying this condition. Also, cognitive training games that combine electronic and precision cognitive training have shown promise in enhancing cognitive function [2]. Additionally, dynamic cognitive training founded significantly effectiveness [3]; that is, integrating electronic cognitive training games with DDA may improve their effectiveness in preventing and delaying dementia [4]. Besides, SVM is a well generalized and efficient classifier, making it an appropriate choice for meeting DDA requirements. Therefore, we conducted an study of the DDA-SVM model utilized machine learning for adaptive difficulty classification.

II. Methods and Results

The DDA-SVM model enhances electronic cognitive training games by using SVM for DDA. Input features include Clock Drawing Test (CDT) result, game difficulty, time, and score. The trained model enables dynamic classification to adjust cognitive training game difficulty. The choice of CDT as an input feature stems from its simplicity and accuracy in assessing the severity of dementia [5]. We conducted a testing process by combining CDT with electronic cognitive training games and invited 53 dementia patients of varying severity to participate. We divided their feature data into training and testing sets (81.13% and 18.87%, respectively) for the SVM model to complete the DDA-SVM establishment. For evaluation, we invited 31 new participants engaging in the DDA-SVM testing process and compared their outcomes with those of participant using the original testing process.

The results revealed after using the DDA-SVM model, 41.94% of the participants experienced a decline in the severity of dementia, while the remaining 58.06% participants maintained their initial level of dementia. In contrast, the participants of original testing process showed only 15.09% improvement, with 67.92% maintaining their initial condition, and a concerning 16.99% exhibited a worsening trend. This provides further evidence of the model's effectiveness.

III. Conclusion

This study presents an effective method to intervene in dementia by combining cognitive training games with DDA. The DDA-SVM model shows promising progress in preventing and delaying dementia. However, limitation such as a small sample size and limited research period should be acknowledged. Future research can expand the sample size and duration for further validation of the DDA-SVM model.

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