

The AppleCatcher Game: A Novel Motor Imagery BCI for Hand Rehabilitation

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Introduction: The AppleCatcher game is a novel motor imagery brain-computer interface (BCI) designed with the idea to facilitate hand rehabilitation for individuals with motor impairments. It was developed to address the limitations of traditional methods by providing a more engaging and user-centered approach to rehabilitation. The system utilizes electroencephalography (EEG) to detect and interpret brain activity associated with motor imagery, allowing users to control a virtual apple-catching game. AppleCatcher leverages the brain's neural plasticity by tapping into the overlapping neural pathways of motor imagery and motor execution. Through mental rehearsal, it can enable users to practice and enhance their motor skills, fostering motor recovery and rehabilitation. Unlike conventional motor imagery-based BCIs that rely on EEG data processing in the sensor space, the AppleCatcher game employs EEG source imaging (ESI) to enhance classification performance. This method has proven effective in improving the accuracy of motor imagery detection. [1, 2].

Material, Methods and Results: The player's objective is to use motor imagery to catch an apple falling on the screen, as shown in Fig. 1. The two vertical lines on the green progress bar serve as markers for when the player is supposed to perform the motor imagery, and data is collected between these two markers using a 32-channel Mentalab Explore EEG cap. Features are extracted from the data by isolating the μ frequency band and then computing the average power of source estimates obtained with sLORETA. These features are classified using Linear Discriminant Analysis, and the output is used to control the virtual hands. For initial testing and validation of the classification pipeline, data from [3] was used. The results of live gameplay tests are promising, with subjects achieving an average accuracy of 75.5%. The accuracy increased by an average of 11.5% between the first and second test session, demonstrating the potential for improving motor imagery skills by playing AppleCatcher. In subsequent offline testing with improved parameters the accuracy rose to 85.0%, equal to the initial test results obtained from the ten best subjects in [3].

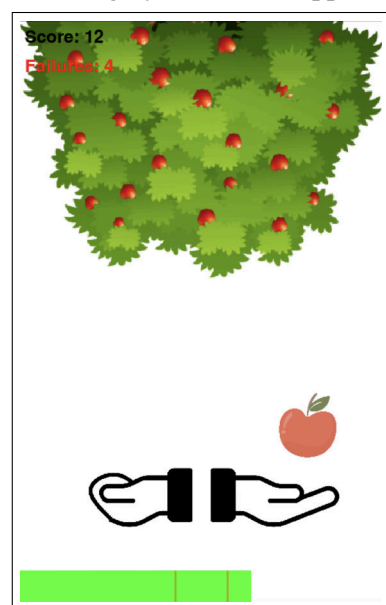


Figure 1: AppleCatcher game interface.

Conclusion: The initial results reported here suggest that the AppleCatcher game serves as a promising proof of concept for a motor imagery-based gaming concept. Further refinement and broader testing with a larger, more diverse participant group are needed to evaluate its effectiveness in hand movement rehabilitation.

References:

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