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Use Raspberry Pi to Study Motion Between People with and Without ADHD

Qinming Yue

Beijing No. 4 High School, China

Abstract

This study aims to explore the feasibility of using motion-sensing smart pen technology to objectively identify the movement characteristics related to Attention Deficit Hyperactivity Disorder (ADHD) in teenagers (aged 12 to 18). We developed a custom smart pen prototype integrating Raspberry Pi 5 and the Sense HAT board, which was used to collect real-time hand movement data (acceleration and direction in 3 axes) during tasks. Data from 18 participants (6 with ADHD and 12 normal control subjects) of various activities (such as SAT exams, creative writing) revealed two key findings: Firstly, the average acceleration in the x-axis of the ADHD patients was significantly lower than that of the control group, and this was consistent across different task types; Secondly, the scatter plot (ax-ay cloud graph) showed that the data of patients with ADHD presented an asymmetric, dispersed distribution pattern, while the data of the control group showed a symmetrical, clustered pattern. Cluster analysis indicated that there was a trend of larger fluctuation range in ADHD patients but it was not significant ($p = 0.138$). In addition, contrary to expectations, the frequency of micro-movement events in the ADHD group was lower ($p = 0.043$), which might be affected by sensor limitations (like the 10Hz sampling rate, and forearm placement method) and the weight of the device (98 grams). Despite limitations such as a small sample size of ADHD cases, this study demonstrates that the kinematic indicators generated by the smart pen have the potential to become a low-cost, objective biomarker for ADHD-related movement disorders. Future research should also need to improve sensor sensitivity, increase sampling rate (>100Hz), and expand the participant group.

Keywords: Attention Deficit Hyperactivity Disorder (ADHD), Motion Sensing Smart Pen Technology, Raspberry Pi 5, Cluster Analysis