# Real-Time EEG-Based Machine Learning System with Behavioral Feedback to Support Attention in Children With ADHD

Al Farsi, Abdulrahman (School: Al Batinah School)
Al Balushi, Al Hussain (School: Al Batinah School)

symptoms of childhood Attention-Deficit/Hyperactivity Disorder (ADHD) may lead to socioeconomic consequences in adulthood, including long-term unemployment. Access to traditional clinical care is frequently obstructed by high expenses, social stigma, and overcrowded clinical services. To cope with these challenges, a low-cost, non-invasive EEG-assisted neurobehavioural system was developed to support sustained on-task attention. The intervention is based on a non-clinical EEG headband. The system integrates positive reinforcement strategies to maintain user engagement. A two-stage machine learning model, trained to generalize across individuals using contrastive feature alignment, predicts inattentive lapses in real time, achieving a Leave-One-Subject-Out Cross-Validation (LOSO-CV) AUC of 0.913 and a Macro-F1 of 0.857 on unseen subjects, with some subjects exceeding an AUC of 0.95 and a Macro-F1 of 0.95. Following detection, the system encourages the child to maintain attention and identify lapses through visual feedback. A token economy system that progressively increases in difficulty and reward was implemented. To address social stigma, the prototype employs discreet interaction modalities suitable for everyday use. The prototype manufacturing hardware costs approximately $313, significantly lower than existing clinical systems exceeding $3,000. In a 4-week parent-consented randomized controlled field trial, the intervention group demonstrated significantly greater sustained attention gains than controls (d', Hedges' g = 1.41; composite Hedges' g = 1.22, after correcting for Type M error), with improvements persisting after device removal. Metrics aligned with blinded assessors’ ratings ($t = 16.2$, $p < 0.001$) and were rated socially acceptable by 90% of participants.

**Awards Won:**