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Auxiliary diagnostic system for ADHD in children based on AI technology

Key words: Attention deficit hyperactivity disorder (ADHD); Auxiliary diagnosis; Computer vision; Deep learning; BERT

Corresponding author: Qiang ZHU

E-mail: zhuq@zju.edu.cn

 ORCID: <https://orcid.org/0000-0002-2405-6776>

Motivation

ADHD: Attention Deficit Hyperactivity Disorder

Prevalence of ADHD children is about 5%–8%

Age	Abnormal behavior
Before 6	Poor self-control, hyperactive
6–12	Communication difficulties, learning disabilities
12–18	Adolescent rebellion, personality impulse
Adult	Lonely, antisocial character

Abnormal behaviors of ADHD patients at different ages

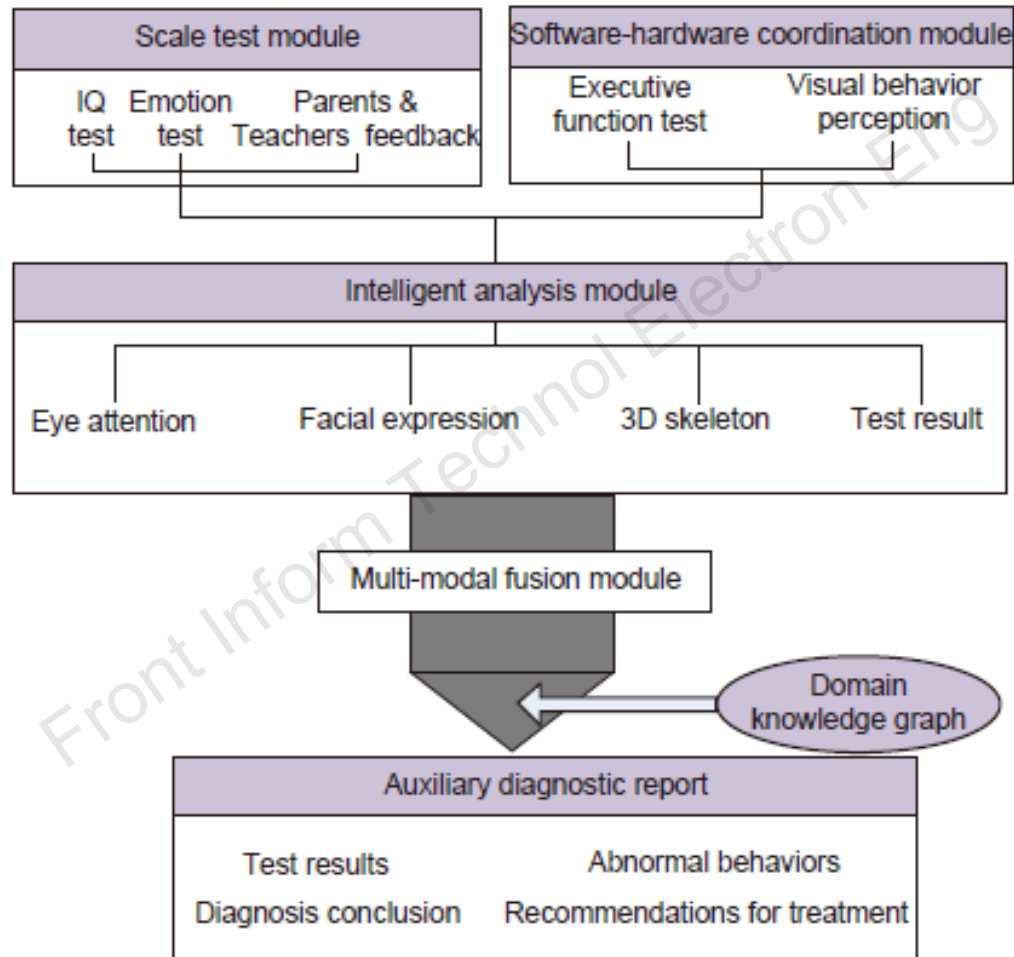
Traditional diagnostic methods

- Interview: doctors communicate with parents
- Observation: children's behavior at visit
- Questionnaire: fill in the paper quality form on site

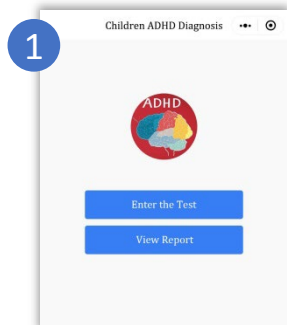
Traditional methods' problem

- Insufficient medical resources
- Lack of medical informatization

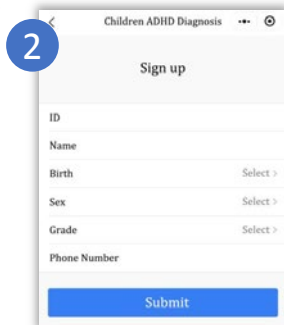
Method



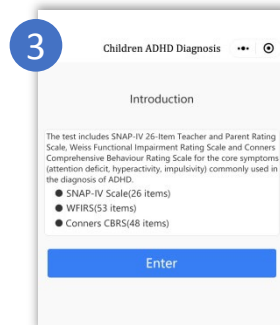
Scale test



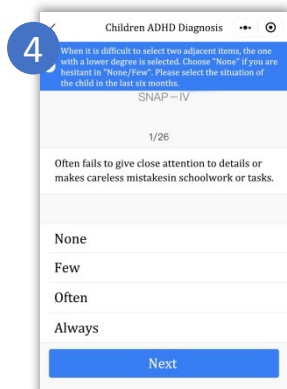
Initial interface



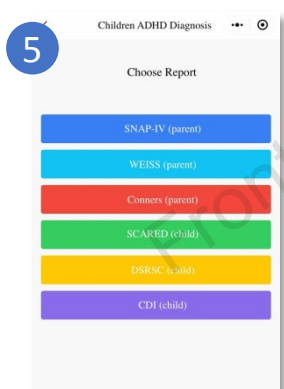
Sign up



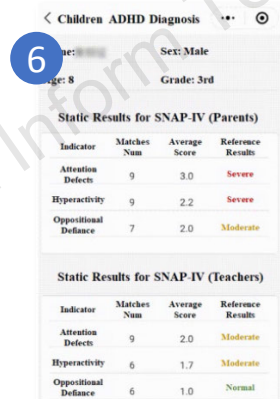
Introduction



Questionnaire



Choose report



Result

IQ test

Raven's SPM

Emotion test

SCARED
DSRSC
CDI

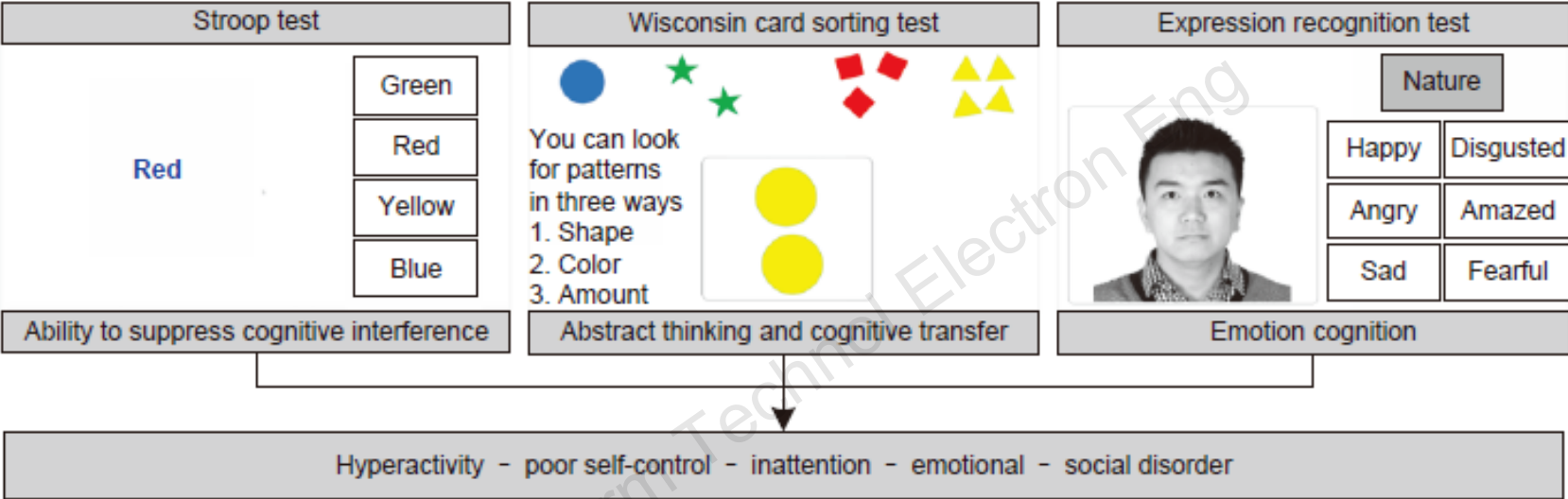
Anxiety disorder
Depression assessment
Severity of depressive symptoms

Teachers & Parents feedback

SNAP-IV
Weiss's
Conner's

Symptoms of ADHD
Social competence
Behavioral and social issues

Comprehensive psychological experiments

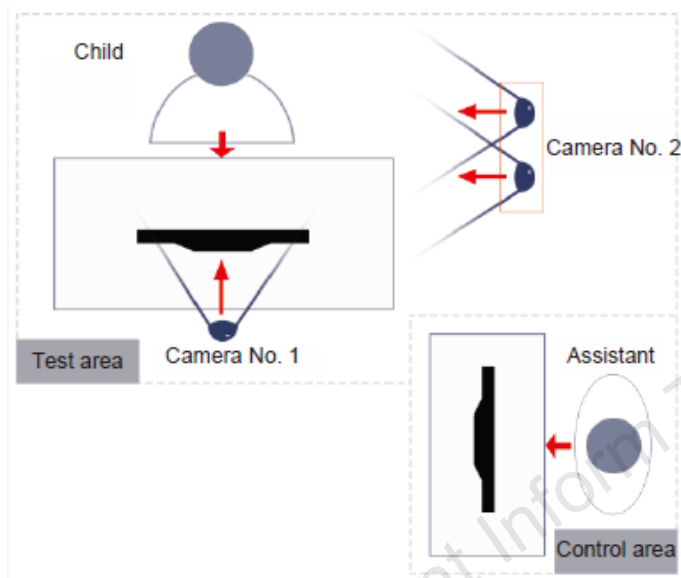


The Stroop test evaluates mainly children's ability to suppress cognitive interference by conflicting word meaning and font color.

Wisconsin card sorting test (WCST) evaluates mainly children's cognitive transferability by changing test rules of color, shape, and quantity.

Expression recognition test evaluates mainly children's social cognitive ability by classifying expressions of face pictures.

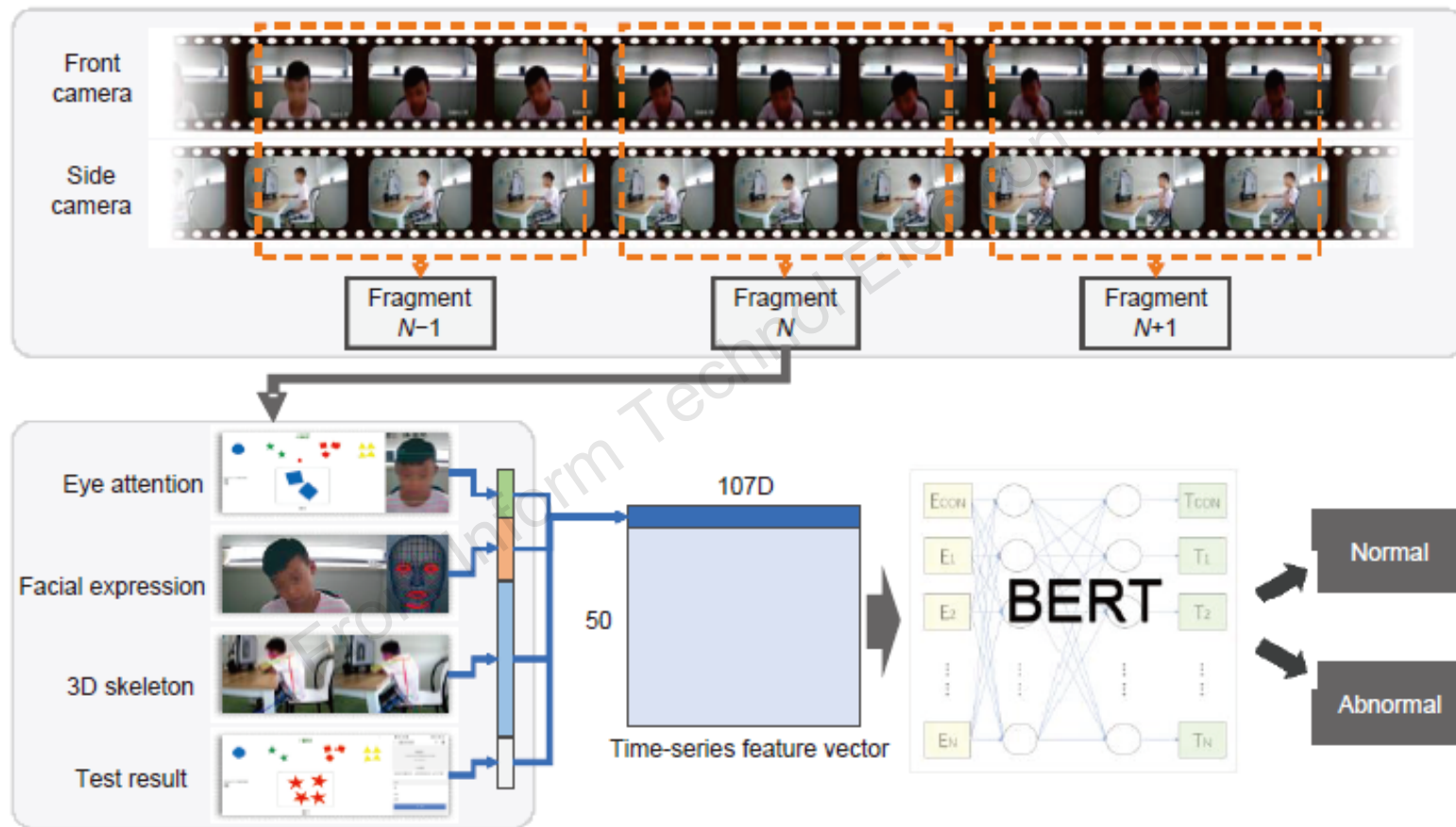
Software-hardware coordination data capture device



Deployed in the hospital since July, 2019
Camera 1 gets the frontal video of the child
Camera 2 gets side videos of the child



Abnormal behavior detection algorithm



Major results

Table 4 Results of abnormal behavior detection

Method	Accuracy (%)	Sensitivity	Specificity	FPR	FNR
GRU	73.10	0.8720	0.5439	0.4561	0.1280
LSTM	76.26	0.8933	0.5894	0.4106	0.1067
BERT (ours)	80.25	0.9357	0.6258	0.3742	0.0643
BERT-eye	76.65	0.9045	0.5836	0.4164	0.0955
BERT-fac	74.95	0.8689	0.5911	0.4089	0.1311
BERT-ske	66.09	0.8970	0.3477	0.6523	0.1030
BERT-ans	74.26	0.8633	0.5837	0.4163	0.1367

FPR: false positive rate; FNR: false negative rate. The best performance of each metric is in bold

We measured the performance of the model through various indicators.

We added two common sequential deep models as control methods: GRU and LSTM.

We also masked information to evaluate the priority of different data: eye attention (BERT-eye), facial expression (BERT-fac), 3D-skeleton (BERT-ske), and the answer of executive functional tests (BERT-ans).

Conclusions and future work

Diagnostic Report

Name: Zhang San

Age: 8

Gender: Male

Date: 2019/10/26

Please scan the wechat code for complete test results



Task / Behavior test

Stroop Test

No obvious abnormalities

WCST (Wisconsin Card Sorting Test)

Abnormal cognitive transfer ability, poor abstract summary ability, especially poor initial concept formation ability, poor insight in concept formation, poor cognitive transfer ability, inattention or confused thinking

Expression Test

No obvious abnormalities

Visual assessment

Stroop Test:

04:15 - 04:36 abnormal behavior

05:20 - 05:35 abnormal behavior

05:57 - 06:05 abnormal behavior

Wisconsin Card Sorting Test:

07:55 - 08:02 abnormal behavior

08:20 - 08:37 abnormal behavior

09:42 - 09:53 abnormal behavior

10:16 - 10:28 abnormal behavior

Expression Test:

12:37 - 13:02 abnormal behavior

14:12 - 14:20 abnormal behavior

16:47 - 16:54 abnormal behavior

17:33 - 17:59 abnormal behavior

Assessment result:

The child is not attentive, and has poor self-control

- **Conclusions:** We have proposed a deep learning model (BERT) to fuse all information for the identification of abnormally behaved segments, with all the visual signals needed. The entire information system standardizes the method of ADHD diagnosis. It provides detailed assessment reports.
- **Future work:** We will promote this system to more hospitals to gather more clinical data. We will also develop the algorithms and the auxiliary program to empower more patients with the AI technology.

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Yanyi ZHANG received her MS degree in pediatrics from Zhejiang University in 2015. She is currently an attending physician in Department of Psychology, The Children's Hospital, Zhejiang University School of Medicine. She is a member of the Committee on Infant Mental Health and a member of the Committee on Mental Health of Children and Adolescents in Zhejiang Province, China. She is a participator in two general projects of the National Natural Science Foundation of China. Her research interests include attention deficit hyperactivity disorder and anxiety disorder.



Ming KONG received his BS degree in computer science from Zhejiang University in 2013. He is currently a PhD student in Institute of Artificial Intelligence, Zhejiang University. His research interests include computer vision and artificial intelligence.



Qiang ZHU received his PhD degree in computer science from University of California, Santa Barbara in 2007. He is currently the dean of Deqing Research Institute of Artificial Intelligence, Zhejiang University, and a Qiushi Distinguished Professor of Zhejiang University. He has worked for University of California, Santa Barbara, Microsoft, and Mitsubishi Electric Research Institute, and has served as the program committee member of the International Conference of Computer Vision (ICCV). His research interests include computer vision, machine learning, and multimedia analysis.