Gaze-Wasserstein: A Quantitative Screening Approach to Autism Spectrum Disorders

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INTRODUCTION

- Early detection of children with autism spectrum disorder (ASD) is essential in maximizing the positive impact of autism intervention. However, a diagnosis of ASD is difficult to receive in a timely manner for the large population.
- In this study, we propose a new ASD screening method, namely Gaze-Wasserstein, that is non-invasive, fast, and widely accessible. Based on the gaze tracking and analysis, Gaze-Wasserstein provides objective gaze pattern-based measurements for home-based ASD screening.

We attempt to answer the following socio(S)-tech(T) challenges:
- How to design effective visual stimuli for diagnosis of ASD? (S)
- Which is the best global gaze pattern matching algorithm? (T)
- How to optimize the screen time efficiency? (S/T)

BACKGROUND AND MOTIVATION

ASD is defined by concerns in three major domains [1]:
- Social interaction – abnormal non-verbal behaviors (ex. gaze).
- Communication – lack of spontaneous social initiatory play.
- Behavior – persistent preoccupation with parts over whole.

Prevalence of child autism
- 1 in 68 children in the US has been diagnosed with ASD [2].
- Significant gap between official government estimate and parent survey.
- Limitations of current approach.

Current diagnostic practice
- Low accessibility
- Specialized clinical setting (ADOS)
- High costs: $3,095 per kit.
- Long duration: 30-45 minutes per modules.

- Subjectiveness
- Dependence on the expertise and experience of physicians

Rationale of our system: Gaze-Wasserstein
- Can provide objective gaze-pattern-based measurements for home-based ASD screening.
- Can be easily deployed on any mobile devices with a front camera.
- Cost-effective, fast, and highly accessible.

METHODS

- Local Access
  - Child at risk of ASD
  - Gaze Pattern
  - Wasserstein
  - KNN Classifier
  - Future Accuracy
  - Visual Error Rate
  - Screening
- Remote Access

VISUAL STIMULI DESIGN

Two categories of visual stimuli
- Social Scene
- Non-Social Scene

Impact of stimuli type on the system performance

ALGORITHM

Typical gaze trend of ASD subjects
- Persistent preoccupation – fixed range of view
- Inability to interpret the relationship depicted in the social scene – wide distribution

_**Similar distribution among TD subjects**_

_**Disimilar distribution among ASD subjects**_

**Modified 1st Wasserstein distance**

- M to N matching of points in two distributions.
- Modified to avoid partial matching by adding a constraint, otherwise some ASD may misclassified as TD.

CONCLUSION

- Using gaze-pattern and social scene stimuli, our method achieved f-score accuracy of 93.96% and equal error rate of 3.30%.
- The evaluation results demonstrate the feasibility of our ASD screening approach in the clinical practice.
- In order to perform Gaze-Wasserstein, only two technologies are needed:
  - Monitor for visual stimuli.
  - Hardware containing the eye-tracking system.
- Both can be provided by smartphones [3].

**BIBLIOGRAPHY**