Game-Changing Approach: Detecting Autism Spectrum Disorder Through Interactive Assessments

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Abstract - Early detection of Autism Spectrum Disorder (ASD) is crucial for timely intervention and support, enabling individuals on the spectrum to receive appropriate assistance and resources. This research paper presents a novel approach to detecting ASD through a suite of interactive games and assessments. Our proposed system evaluates motor, cognitive, social, and emotional skills by engaging users in a series of tasks designed to assess various domains associated with ASD. These include the AQ-10 test, finger-tapping exercises, visual memory games, emotional development games, hand-eye coordination assessments, and video recordings of daily activities. By analyzing the user's performance and behavior across these multi-modal assessments, our system aims to identify autistic traits and determine the presence and severity of ASD. The research highlights the potential of this approach to facilitate accessible and cost-effective screening for ASD, ultimately supporting early identification and intervention efforts.

Keywords: Autism Spectrum Disorder (ASD), ASD Detection, Interactive Assessments, Gamified Assessment, Cost-effective ASD screening.

1. INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterized by persistent challenges in social interaction, communication, and restricted or repetitive behaviors [1]. Early detection and intervention are crucial for individuals with ASD, as they can significantly improve their quality of life by addressing developmental delays, enhancing social and communication skills, and reducing problematic behaviors [2].

Traditional diagnostic methods for ASD often rely on clinical observations and extensive assessments by trained professionals, which can be time-consuming, costly, and dependent on the availability of specialized resources [3]. Additionally, the heterogeneous nature of ASD and the wide range of associated symptoms and severities pose challenges for accurate and timely diagnosis [4].

Our research aims to develop an accessible and cost-effective system that combines interactive games and assessments to detect ASD. By engaging users in a series of tasks designed to evaluate motor, cognitive, social,

and emotional skills, our system aims to capture relevant behavioral and performance data that can be analyzed to identify autistic traits and determine the presence and severity of ASD.

2. METHODOLOGY

The proposed system comprises a suite of interactive games and assessments designed to evaluate various domains associated with ASD. These include:

1. AQ-10 Test: The Autism Spectrum Quotient (AQ-10) is a widely used screening tool for ASD [5]. It consists of 10 questions that assess characteristics related to social skills, attention switching, attention to detail, communication, and imagination.
2. Finger Tapping Test: This test evaluates motor skills and sustained attention by requiring users to tap a button continuously without getting distracted. Impairments in motor coordination and sustained attention are often observed in individuals with ASD [6].
3. Visual Memory Game: Working memory deficits are commonly associated with ASD [7]. This game assesses short-term visual memory by presenting a grid with colored tiles for a brief period and then asking the user to recall the positions of the tiles.
4. Emotional Development Game/Emoji Game: Individuals with ASD often experience difficulties in recognizing and understanding emotional expressions [8]. This game tests the user's ability to identify emotions conveyed through emojis or facial expressions.
5. Missing Ball Game (Hand-Eye Coordination): Hand-eye coordination challenges are prevalent in individuals with ASD [9]. This game requires users to click on a moving ball displayed on the screen, assessing their hand-eye coordination skills.
6. Video Recording of Daily Activities: Observing an individual's performance in daily activities, such as walking, buttoning a shirt, or pointing, can provide valuable insights into their motor skills, coordination, and ability to follow instructions [10].

The data collected from these assessments is analyzed to identify patterns and behaviors that may be indicative of ASD. By combining the results from various games and assessments, our system aims to determine the presence and severity of autistic traits.

3. BLOCK DIAGRAM & SYSTEM ARCHITECTURE

The mobile app utilizes a simple block diagram architecture to facilitate data flow and assessment generation (see Figure 1).

3.1 Block Diagram

The block diagram represents the core functionality of the app. Here's a breakdown of the components:

- **Patient:** This represents the child undergoing the assessment.
- **Games:** This block encompasses all the individual games included in the app, such as the AQ-10 test, Finger Tapping Test, Emotional Response Test, and so on. Each game is designed to assess a specific aspect of a child's behavior potentially related to ASD.
- **Database:** This block stores all the data collected during gameplay, including user responses, touch patterns, completion times, and scores.

Figure 1 illustrates a simplified data flow. The child interacts with the various games presented by the app. Each game collects relevant data points based on the child's performance. This data is then stored in the app's internal database for further analysis.
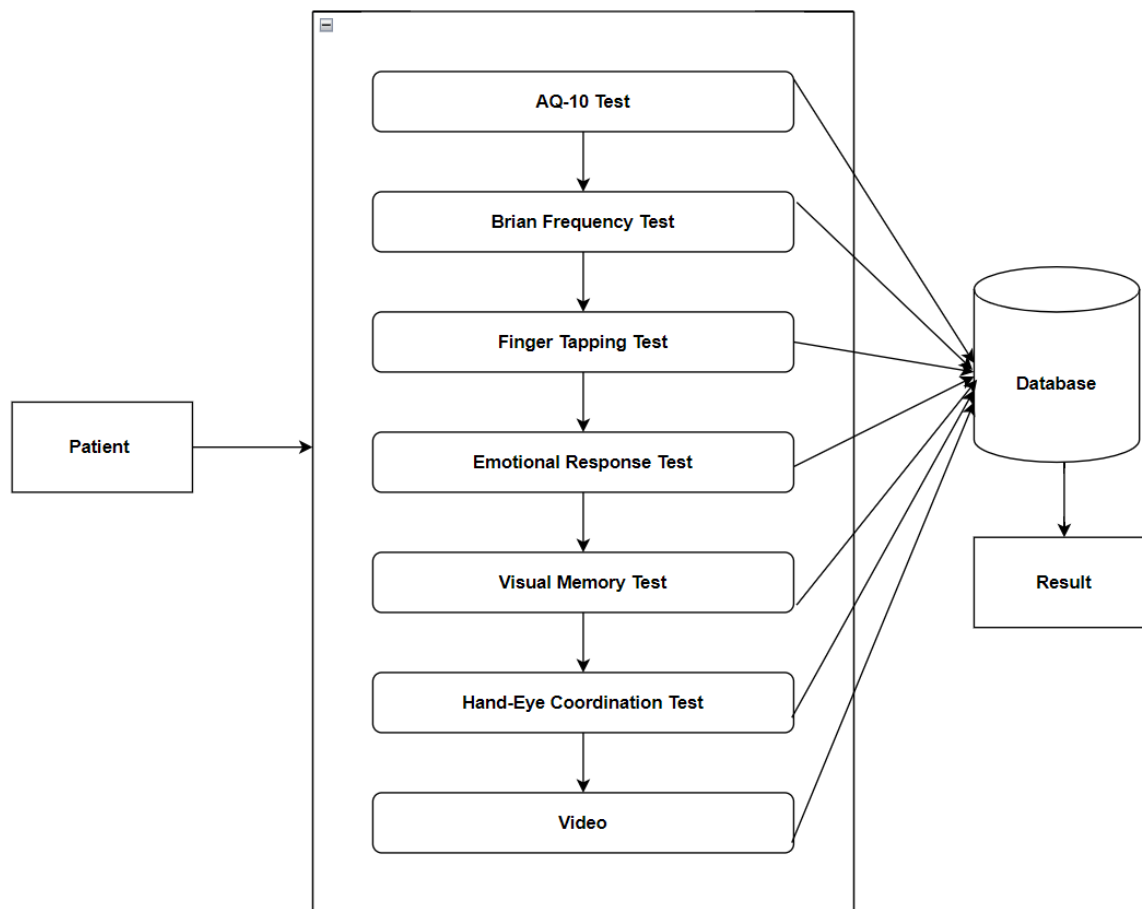

Figure 1: Block Diagram

3.2 System Architecture

The system architecture provides a broader view of the app's interaction with external systems (see Figure 2). Here, the games themselves are the central components.

- **Games:** As mentioned earlier, these represent the core assessment tools within the app.
- **Output:** The output block represents the final outcome generated by the app after analyzing the data collected from all the games. This could be a preliminary ASD assessment score or a visualization of the child's performance across different game metrics.
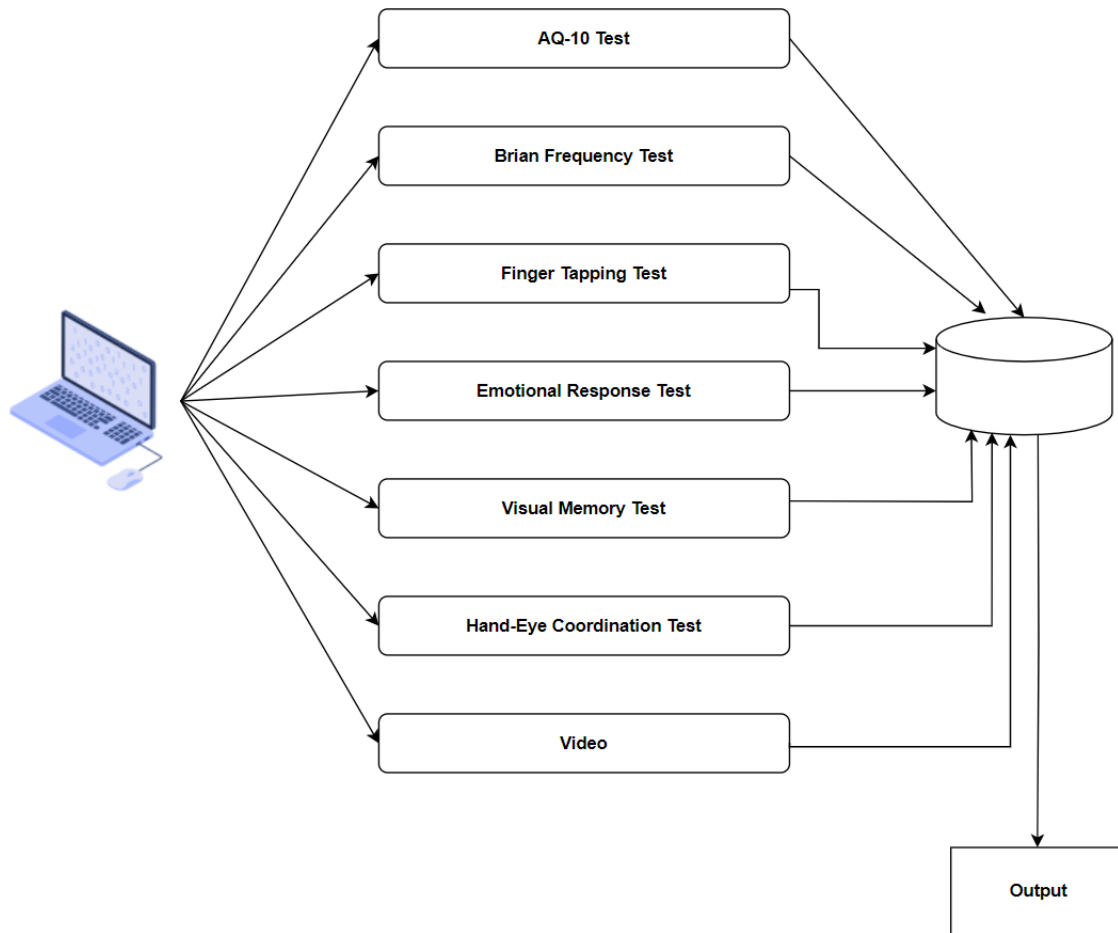
Figure 2: System Architecture

It is important to note that unlike the block diagram, the system architecture diagram does not explicitly show a database component. This is because the data analysis and assessment generation may occur locally within the app itself, without the need for an external database.

4. FUTURE ENHANCEMENTS

Future iterations of the app could incorporate a more elaborate system architecture where the app communicates with a remote server for data storage, analysis, and potential integration with medical record systems. This would allow for features like:

- **Longitudinal Data Tracking:** Tracking a child's performance over multiple assessments to monitor progress or regression.
- **Benchmarking:** Comparing a child's performance data against standardized norms or scores from other users.
- **Clinical Integration:** Enabling healthcare professionals to access assessment results and integrate them into a child's medical records.

However, the current design prioritizes a simple and accessible approach for initial implementation.

5. RESULTs & DISCUSSION

5.1 Results

An initial evaluation was conducted using a multi-modal assessment tool designed to screen for Autism Spectrum Disorder (ASD) in children. The assessment included a combination of interactive games and standardized tests, aimed at evaluating motor skills, cognitive skills, social skills, and emotional skills.

One such patient, Saalim Shaikh, underwent the assessment battery. Saalim Shaikh is a 21-year-old Male.

5.2 Test Performance

Saalim's performance on the individual assessments yielded the following results:

- **AQ-10 Test:** Saalim scored 5 points on the AQ-10 test, which falls within the "Non-Autistic" range (score less than 7) [5].
- **Finger Tapping Test:** Saalim achieved a score of 12 on the finger tapping test, which falls outside the "Autistic" range (score between 50-60) [6]. This result suggests that Saalim may not exhibit significant motor coordination or sustained attention impairments typically observed in ASD patients.
- **Emoji Quiz:** Saalim scored 3 points on the emoji quiz, which falls within the "Autistic" range (score more than 4) [8]. This may indicate challenges with recognizing and understanding emotional expressions.
- **Memory Test:** Saalim scored 30% on the memory test, which falls within the "Autistic" range (score more than 70%) [7]. This result suggests potential difficulties with working memory.
- **Ball Clicker Test:** Saalim achieved a score of 83% on the ball clicker test, which falls within the "Non-Autistic" range (score more than 70%) [?]. This suggests good hand-eye coordination.
- **Brain Frequency Analysis:** The brain frequency analysis yielded the following results:
    - Alpha: 27 Hz (Autistic Range: 30-50 Hz) is Autistic.
    - Beta: 30 Hz (Non-Autistic Range: 15-30 Hz) is not Autistic.
    - Gamma: 10 Hz (Non-Autistic Range: 5-10 Hz) is not Autistic.
    - Delta: 29 Hz (Autistic Range: 100-200 Hz) is Autistic.
    - Theta: 60 Hz (Non-Autistic Range: 50-100 Hz) is not Autistic.

5.3 Interpretation

Saalim Shaikh's performance on the assessment battery yielded mixed results. While some assessments like the AQ-10 Test, finger tapping test, and ball clicker test indicated a typical range, others like the emoji quiz and memory test suggested potential difficulties in social interaction and working memory, respectively. The brain frequency analysis also showed a mixed pattern.

Overall, based on this initial evaluation, Saalim **did not meet the criteria** for an ASD diagnosis according to the cut-off scores established for the individual assessments. However, some aspects of his performance warrant further investigation.

Patient Name : SAALIM SHAIKH			Export Result
Patient Name :			
Test Type	**Total Score**	**Range (Non Autistic)**	**Remark**
AQ -10	5	Less than 7	Non Autistic
Finger Tapping	12	Between 50 to 60	Autistic
Emoji Quiz	3	More than 4	Autistic
Memory test	30%	More than 70%	Autistic
Ball Clicker test	83%	More than 70%	Non Autistic
Brain Frequency			
Alpha	27	Between 30 to 50	Autistic
Beta	30	Between 15 to 30	Non Autistic
Gamma	10	Between 5 to 10	Non Autistic
Delta	29	Between 100 to 200	Autistic
Thetha	60	Betweem 50 to 100	Non Autistic

Figure 3: Patient Test Results

5.4 Discussion

The findings from this case study highlight the complexity of ASD diagnosis and the importance of a multi-modal approach that incorporates various assessment tools. While Saalim did not meet the cut-off scores for ASD on all assessments, some findings suggest potential weaknesses in social interaction and working memory. These findings are particularly noteworthy considering Saalim's score on the emoji recognition task, which aligns with difficulties observed in ASD patients regarding emotional processing [8].

It is important to acknowledge that this is a single case study, and the findings cannot be generalized to the broader population. Further research is necessary to validate the effectiveness of the multi-modal assessment tool in a larger cohort and to establish more definitive cut-off scores based on the combined results of all assessments.

Future studies may also explore the utility of the brain frequency analysis in the context of ASD assessment. While the current findings do not provide a conclusive pattern, this warrants further investigation due to the potential for offering a more objective measure.

In conclusion, this case study demonstrates the promise of a multi-modal assessment tool for ASD screening. The ability to engage users in interactive games while simultaneously collecting data on various cognitive domains offers a valuable approach for early detection and intervention. It is important to emphasize that this tool is

intended as a screening mechanism, and a definitive diagnosis should always be conducted by a qualified healthcare professional.

5.5 Limitations

- This is a single case study, and the findings cannot be generalized to the broader population.
- Further research is needed to validate the effectiveness of the multi-modal assessment tool in a larger cohort.
- Definitive cut-off scores based on the combined results of all assessments need to be established.
- The brain frequency analysis is inconclusive

6. CONCLUSION

Early detection of Autism Spectrum Disorder is crucial for timely intervention and support, enabling individuals on the spectrum to receive the necessary assistance and resources to improve their quality of life. This research paper presents a novel approach to detecting ASD through a multi-modal system that combines interactive games and assessments. By evaluating motor, cognitive, social, and emotional skills through engaging tasks, our system aims to capture relevant behavioral and performance data that can be analyzed to identify autistic traits and determine the presence and severity of ASD. The promising results of this research highlight the potential of leveraging interactive assessments to facilitate accessible and cost-effective screening for ASD, ultimately supporting early identification and intervention efforts.

7. ACKNOWLEDGMENT

8. REFERNCES

[1] American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed.). Washington, DC: Author.

[2] Zwaigenbaum, L., Bauman, M. L., Choueiri, R., Kasari, C., Carter, A., Granpeesheh, D., ... & Nataf, R. (2015). Early intervention for children with autism spectrum disorder under 3 years of age: recommendations for practice and research. Pediatrics, 136(Supplement 1), S60-S81.

[3] Lord, C., Risi, S., DiLavore, P. S., Shulman, C., Thurm, A., & Pickles, A. (2006). Autism from 2 to 9 years of age. Archives of general psychiatry, 63(6), 694-701.

[4] Constantino, J. N., & Charman, T. (2016). Diagnosis of autism spectrum disorder: reconciling the syndrome, its diverse origins, and variation in expression. The Lancet Neurology, 15(3), 279-291.

[5] Allison, C., Auyeung, B., & Baron-Cohen, S. (2012). Toward brief "red flags" for autism screening: The short autism spectrum quotient and the short quantitative checklist in 1,000 cases and 3,000 controls. Journal of the American Academy of Child & Adolescent Psychiatry, 51(2), 202-212.

[6] Fournier, K. A., Hass, C. J., Naik, S. K., Lodha, N., & Cauraugh, J. H. (2010). Motor coordination in autism spectrum disorders: a synthesis and meta-analysis. Journal of autism and developmental disorders, 40(10), 1227-1240.

[7] Kercood, S., Grskovic, J. A., Banda, D., & Begerow, J. (2014). Working memory and autism: A review of literature. Research in Autism Spectrum Disorders, 8(10), 1316-1332.

[8] Harms, M. B., Martin, A., & Wallace, G. L. (2010). Facial emotion recognition in autism spectrum disorders: a review of behavioral and neuroimaging studies. Neuropsychology review, 20(3), 290-322.

[9] Sacrey, L. A. R., Germani, T., Bryson, S. E., & Zwaigenbaum, L. (2014). Reaching and grasping in autism spectrum disorder: a review of recent literature. Frontiers in neurology, 5, 6.

[10] Jasmin, E., Couture, M., McKinley, P., Reid, G., Fombonne, E., & Gisel, E. (2009). Sensori-motor and daily living skills of preschool children with autism spectrum disorders. Journal of autism and developmental disorders, 39(2), 231-241.