A Comprehensive Diagnosis And Treatment Application For Autism Spectrum Disorder

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Abstract- *Autism is among the most prevalent and concerning mental disorders, with approximately 1 in 54 children having been diagnosed with autism spectrum disorder (ASD). Diagnosing autism at an early age is imperative for treating the disease as early as possible but is made difficult by the high degree of subjectivity in its diagnosis. A cloud-based application to diagnose, prevent, and treat autism is proposed. This application will be able to diagnose autism from eye movement patterns in new-born babies. Subsequently, the application will guide the child and their parents through treating the disorder while also providing daily lifestyle guidance.*

Keywords- artificial intelligence, deep learning, medicine, autism spectrum disorder

I. INTRODUCTION

Autism is among the most prevalent and concerning mental disorders, with approximately 1 in 54 children having been diagnosed with autism spectrum disorder (ASD). ASD is a developmental disorder that is characterized by difficulties in social communication and interactions, as well as unusual repetitive behaviors; additionally, the inability to establish and maintain eye contact or focus on a specific task for extended periods of time are also symptomatic of ASD.

Although autism emerges during childhood, its effects permeate throughout one's lifetime. Adults previously diagnosed with autism are more susceptible to develop such diseases as diabetes, schizophrenia, heart disease, and depression. Additionally, people with autism often encounter obstacles when attempting to join the workforce; this is evidenced, by one in five of the aforementioned people being unemployed, resulting in nearly half being forced to permanently reside with a family member. Contributing to this is the fact that merely 5% of adults with autism ever become married.

Diagnosis of ASD at an early age provides axiomatic benefits for both the child and the family. For example, if an autistic child is diagnosed between 18-24 months of age and provided with two years of intervention, the child gains an average of seventeen IQ points. In comparison, autistic children diagnosed at age four typically have an unchanged IQ by the time they reach adulthood, in spite of the same treatment. Thus, the phenomenon of growing out of autism is contingent upon expeditious intervention. However, the average age of ASD diagnosis is over 4-years-old; consequently, their treatment usually yields insignificant benefits due to having passed the suitable age for intervention.

II. RESEARCH

Autism spectrum disorder is a condition that encompasses several mental disorders, including autistic disorder, Asperger syndrome, Childhood Disintegrative Disorder, pervasive develop 5 mental disorder not otherwise specified (PDD-NOS), and Rett Syndrome. It affects more than 3.5 million Americans and is the fastest-growing developmental disability, with a 119.4% increase in prevalence from 2000 to 2010. Accordingly, autism services cost U.S. citizens approximately $236-262 billion per year, with the vast majority ($175-196 billion) being invested in adult services. Two-thirds of this cost can be reduced through early detection, exemplifying the need to mitigate autism's effects before adulthood. This exorbitant cost is partially due to merely 19.3% of the U.S. disabled population joining or attempting to join the workforce; furthermore, of those people, only 16.8% are employed. By comparison, 69.3% of non-disabled Americans are in the workforce, with 65% of them being actively employed.

The effects of autism extend beyond just employment, with its effects permeating to other realms of life as well. Since leaving high school, nearly 9 in 10 adults with autism reside with their parents, the illness rendering them incapable of taking proper care of themselves; they are consequently unable to go through typical milestones in life, such as getting married or having children.

Additionally, there are a multitude of linguistic and behavioral consequences for children with ASD. They exhibit abnormal language and behavior patterns such as repetitive or rigid language, narrow interests, uneven language development, and poor nonverbal conversation skills. The interpersonal communication skills of autistic adults are insufficient for higher-level occupations, explaining their shockingly low employment rate.

III. THE CONCEPT

We propose a multi-faceted, cloud-based application to diagnose, treat, and assist autistic children with their daily routines; this app will consist of three distinct components.

The first component will diagnose autism by tracking the visual patterns of the participants' eye movements. The user will be instructed to follow a moving object on the screen of their device while maintaining focus for ten thirty second periods. Simultaneously, their eye movement patterns will be tracked via their device's camera to provide a diagnosis regarding whether or not they are autistic. If the diagnosis is returned as positive for autism, the app directly connects the family to the most convenient pediatric neurologist available. The child will receive formal clinical testing to reveal where they fall on the autism spectrum. Based upon the severity of the diagnosis received, the app will develop an intelligent and adaptive treatment plan for the child, which is the second component of our app.

This plan utilizes the behavioral and communication approach to help mitigate symptoms of autism. Seeing as the target age range for the diagnosis of autism using the app is around 24 months, the plan will begin by using the Early Start Denver Model (ESDM), a type of applied behavior analysis (ABA). The ESDM is an in-home intervention program used by parents and therapists by engaging in joint play activities including treatment, educational, and community to help the child advance their social, language, and cognitive skills. The next type of ABA is the Discrete Trial Training (DTT) technique in which the parents use a series of directed mass instruction and positive reinforcers to teach a desired behavior or response. The instructions are broken down into small simple parts, where correct answers are rewarded, while wrong answers are ignored. For example, if a parent is trying to teach his/her autistic child colors using the DTT method, they may begin by teaching just the color red. They would ask the child to point to the color, then reward the child with a toy or candy. They would then continue this method with the other colors. The next method is the Verbal Behavior Intervention (VB) technique which teaches communication, language, and verbal skills to the child. This technique works by encouraging the child to associate words with their purposes when learning a language. It focuses on why words are used and how they can communicate ideas and help the child get their desired objects or results. For example, through VB, a child would learn that the word "cookie" gives them a cookie. The next technique used is the Early Intensive Behavioral Intervention (EIBI) technique which is often used for children ages 3-5. This approach utilizes structure to build and increase positive and useful behaviors, while decreasing unwanted behaviors like aggression. It consists of a Discrete Trial Training procedure that is given in a one-on-one adult to child environment. It is similar to homeschooling a child, however each session will be customized to each child's skill level. This part of the plan will carefully address specific behaviors that are able to be observed, measured, and recorded in order to track the child's progress in learning, communication, etc.

IV. ETHICAL CONSIDERATIONS

All three components of our AI system operates and function efficiently and accurately while maintaining the highest standard of fairness. They each operate independently of racial, socioeconomic, and geographic factors, which is essential for multiple reasons. First, it diagnoses the user for autism spectrum disorder (ASD) independent of the aforementioned factors, both of which are unrelated to the diagnosis process, guaranteeing users a reliable and fair diagnostic tool. Additionally, it ensures that upon positive diagnosis, all users receive a treatment and lifestyle plan of equal quality and fairness.

Our AI system is also designed to ensure maximal inclusiveness. By only requiring an internet-connected device, our app is accessible for usage to families of all backgrounds. This is important as autism does not discriminate between race, socioeconomic status, or geography, rendering all children equally susceptible; thus, it is essential that access to treatment therapies are as widespread as possible. Because our treatment plan is free, it bypasses any potential financial limitations or burdens upon families, thus overcoming the economic barrier. Because our AI system is involved in life-changing and momentous aspects of families' lives, it is of utmost importance that it performs reliably and safely. The determination of the diagnosis component of our proposed system is immediately validated and confirmed by a licensed pediatric neurologist, minimizing the number of false positives predicted.Additionally, the therapeutic intervention exercise tutorials in our app are provided by autism therapists to ensure that the exercises are safe for the children.

Furthermore, our AI system protects patient confidentiality by only disclosing pertinent information to medical personnel who the users and their respective families authorize. The questions answered by the parents after each therapy session will be kept confidential and serve the single purpose of creating and improving upon the treatment plan for the child. Our AI system will ensure full transparency with all involved parties. Before beginning diagnosis with our system, the parents will be fully made aware of what data the app will be recording and what the data will be used for. Before using the system, each family will be mandated to read through and

agree to the terms and practices of our proposed system, ensuring they gain complete knowledge of how the system works and what their inputted data will be used for.

Lastly, we ensure accountability and controllability by humans through doctors themselves. Each step of our proposed concept is verified by pediatric neurologists specialized in autism ensuring safety for the users. No step is taken without the approval of an autism specialist, further accounting for the controllability factor.

V. SOLVING THE PROBLEM

A child who is diagnosed between the ages of 18-24 months of age can experience an overall IQ gain of about 17 points, while a child diagnosed at four years of age (the average age to be diagnosed) sees no overall IQ gain with the same types of intervention. The main reason children are currently diagnosed so late is due to the fact that isis hard for parents to distinguish between symptoms of autism and childish behavior at such a young age as well as the fact that on average it takes a year for a child to get tested for autism after the parents first suspect symptoms and request for their child to be tested. In the first phase of our concept we provide a simple and easy to use method to diagnose autism at home just by tracking the child's eye movements and patterns. Due to its extreme convenience, the goal is for every child to be tested using this software between the ages of 18-24 months for autism to ensure that intervention can be successful. With this program for readily available autism in place, there should be no reason for any autistic child to not live a close to normal life.

The next issue is that many parents cannot afford the therapies required for an autistic child. Specifically, in a study conducted by OHSU Doernbecher Children's Hospital, 30 percent of children with mild autism were not using any of the services such as speech or language therapy that was needed, and about 25 weren't seeking any medical specialists. Of children with severe autism, 50 percent of children were not using any behavioral interventions, and 1 in 10 children with severe autism were not seeing medical specialists at all. When looking at the main reasons for this, cost and accessibility were among the top two. The proposed phase 2 of the concept mitigates these problems. By creating free in home adaptable therapy plan, just as therapists would do, we are allowing parents to give their children clinically approved medical care at their own convenience. By providing video examples of each of the therapy exercises the child needs, parents can simply follow along with their own children at no cost and provide their children with independent futures they would not have had otherwise.

The proposed autism program clearly addresses all aspects of the AI for Accessibility problem: employment, daily life, and communication. As mentioned before, currently 1 in 5 adults and 85% of college graduates diagnosed with autism have trouble entering the workforce. This is mainly due to the fact that due to late diagnosis and a lack of intervention, these adults have poorly developed communication skills and cannot perform well in medium-high skill jobs. However, with the early diagnosis of autism and the therapeutic interventions provided by this program, all autistic children will have the resources they need to increase their communication and self management skills needed for them to be successful in a work environment. With the help of the daily routine model in phase 3 of our concept, the autistic adults can work through and learn new daily routines that involve their work activities. With little to no adjustments and resources needed from the employers themselves, they would be more willing to hire these adults. The next problem addressed in our concept is with daily life. This is directly what the third aspect of our concept attacks. After learning and developing the skills needed, the children apply what they have learned in their own daily lives. As adults, only 17% of those diagnosed with autism live independently, with just under half still living with their parents. This is likely a direct cause to the low percentage (5%) of adults with autism to be married. These adults do not live independently because they are not able to complete essential daily tasks by themselves. By targeting children diagnosed with autism and motivating them to follow daily routines independently at an early age, we are shaping them for their future and allowing their learning abilities to improve. After following routines with such strong guidance, they will soon be able to complete the learned daily routines by themselves. In the future, this would allow them to complete their own activities independently and live a somewhat normal life. The last problem addressed is the communication aspect. Most autistic children do not have the ability to communicate with others on a high level if at all due to a lack of intervention. According to multiple studies, speech and language therapies are the leading methods for improving communication skills. With the proposed concept, all autistic children would have access to these methods in the time frame they need.

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