

A Therapeutic Tool to Diagnose ASD in Children

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Abstract—Today the autism rate in Sri Lanka is increasing and 1.07% that is 1 in every 93 children is affected by autism. Among south Asian countries Sri Lanka has been reported with highest prevalence. Many factors affect the behavior of an autistic child, and an interaction is needed for the improvement of their behavioral patterns. It is identified that music therapy could play an important role as an intervention method to increase the social, interactive, and communicative skills of the affected children as well as to manage the challenges faced by them. The aim of this research is to identify and analyze the problems faced by the autistic children and their guardians when looking after them and identifying how diagnosis can be done with emotion API and ASSQ questionnaire and how the challenges such as stress, anxiety, depression can be controlled and improved using music.

Index Terms—ASD, facial recognition, autism spectrum screening questionnaire, music therapy, progress analysis

I. INTRODUCTION

Autism Spectrum Disorder (ASD) is described as a neurodevelopmental condition of inability to socialize and communicate and an act of unusual behaviors. Therefore, autism intervention is much more effective if it is done consistently [1], [2]. There is no complete cure for ASD, but when proper guidance is provided, the affected individual will be able to improve their skills which will pave the way for an independent life later in their lives. One of the challenges faced by ASD individuals and their families is difficulty in diagnosing ASD [3], [4]. Currently there are no autism screening tools that are used in Sri Lanka among pediatricians that would assist with the diagnosis [5], [6]. A study in a small urban area of Sri Lanka has demonstrated 1 in every 93 children is affected by ASD, the prevalence of ASD among children today might be higher than what we think [7]. It affects an incredibly significant percentage of the citizens. The health and education services in Sri Lanka are only just beginning to wake up to this reality, but there is still ignorance among the public [8], [9].

II. BACKGROUND

Apart from the main problem which is difficulty in diagnosing ASD for children between 7 – 16 years there are several other issues that are faced by the affected children as well as their parents, teachers, and their caretakers. Below mentioned are such issues that are identified throughout the research.

A. Lack of Communication and Interactive Skills of Children Affected by ASD

Children with ASD lose certain skills they once had as they grow with the disorder [10]. The ability to understand and express emotions starts developing from birth but ASD children will not be good at recognizing and expressing emotions. They will not have the capacity to keep companions even though they have the desire for friendships. They also regularly have trouble in communicating nonverbally as they avoid eye contact, which can make them seem uninterested or inattentive [11]. They are often unable to use gestures to give meaning to their speech and not understand what others state to them [12], [13]. They undergo a repetitive and disruptive behavior causing trouble to the surrounding public. They also speak with no meaning or not relatable to the conversations. When there are any changes in the daily routine, they might experience a difficulty to get adapted to it and need help to manage [14]-[16].

B. Inability to Completely Cure ASD

There is no complete cure for ASD but some medicines can help to reduce symptoms like depression, seizures, insomnia, and trouble focusing. There are also certain therapies which would help to reduce symptoms in ASD children, such as Speech and language therapy, Music therapy, Occupational therapy, Acupuncture, Massage therapy, Responsive Prelinguistic Milieu Teaching, Neurofeedback, and such. These programs help with child's overall development. However, behavioral treatment and skills training programs for an ASD child or their parents/caregivers, can reduce difficulties in communication and social behavior, with a positive impact on the individual's quality of life [17]. Studies have shown that medication is most effective when it is combined with behavioral therapies. An individual's treatment plan can include behavioral interventions, other therapies, medicines, or a combination of these. A work of progress tracking could help ASD individuals to track the progress of them, and the parents can have an idea of how their child is having an improvement through the treatments which will help to improve the skills [18].

C. Inadequate Treatments and Consideration for Severe Spectrum Conditions

Severe spectrum conditions are not equally given importance and treated properly same as the mild or moderate conditions. Sometimes hope is lost, and severe conditions are not taken care of properly. Most of the

specialized educational centers are only for mild or moderate conditions of ASD. ASD symptoms can occur to a mild degree in children who are stressed, anxious and depressed, then lead to severe conditions if not treated properly [19]. So the children need to be looked after very well and make sure the mild conditions do not lead to the severe conditions, because when a person undergoes a severe spectrum condition, he/she is left out without care, losing hopes for treatment [20].

D. Lack of Education Life Importance Given to Severe Spectrum Conditioned Individuals

A growing number of ASD students enrolls in higher education and although they have the potential to perform well academically, they are at a risk for academic and personal failure during the educational years [21]. And as Sri Lanka is a country which values education highly which mandates free education for all it would be difficult for an ASD child to achieve what is wanted [8]. Special needs children with mild and moderate conditions in Sri Lanka are educated either in specialized schools or in integrated special education programs within regular schools but children with severe conditions are not taken care of properly due to the difficulties present in educating and making them understand [20], [22].

E. Lack of Interaction or Socialization of People around the Individuals Affected by ASD

Individuals affected by ASD have great difficulty with social reciprocity in understanding and responding to social cues and will frequently misunderstand social situations which leads to great frustration and problems for people around them [23]. Due to their aggressive behavior in the public environment, the people in the society will avoid the contact with the individuals affected as much as possible. They eventually go under isolation which will itself lead to anxiety and depression to lead to serious severe conditions.

F. Unavailability of Platforms to Help the Communication and Interactive Skills of ASD Affected Individuals Using Music Therapy

An interactive music therapy could help ASD individuals to appropriately express their emotions because music is processed in both hemispheres of the brain, it can stimulate cognitive functioning [24]. But there aren't any platforms to provide the required music therapy for the affected children which would help in their communication, interaction and social adaptation skills. [25]. Studies have suggested that a music therapy is a valuable option as a treatment for autism children which can be eventually used for self-expression, socialization, rehabilitation, psychological enrichment, and recreation for the affected individual [26].

G. Inability to Make Use of Technology due to Challenges in Usability and User Experience of Certain Mobile/Web Applications for ASD Children

The user experience of a mobile/web application needs to be built in favor to the ASD children as it is one of the

challenges for them. Children with autism experience differences in life experiences with disabilities and as they are visual thinkers, visual support is one of the tools to enable communication, learning and development of skills. It is crucial to develop a platform by following favorable design guidelines and principles for Autism users. [27] The user experience of the application should be meaningful, usable, desirable to produce positive emotions, credible and valuable which paves for interactions and development of the cognitive skills of ASD children. [28]

III. RESEARCH GAP

When considering the features of the proposed solution, some similar components are available individually. However, the purpose of the project is to diagnose whether a child is affected by ASD and to help guardians to adopt and monitor individual development of each child through progress analysis. The proposed solution consists of unique features compared to other solutions available online. The existing solutions contains primary information on what is autism, what causes ASD and other guidance for parents, teachers, and caretakers of the affected individuals. Considering Sri Lanka such information is limited [29], [30]. Furthermore, an application with a diagnosis option as well as a music therapy along with a gaming progress analysis are not available [31].

A. Gap Analysis

The following Table I and Table II describes the features of the web and mobile applications that have been selected to compare with the proposed solution. A total of 12 applications have been considered that are available world-wide and not particularly in Sri Lanka. [32], [33].

TABLE I. GAP ANALYSIS OF WEB AND MOBILE APPLICATIONS

Name of the app	Monkey Drum	Autism iHelp – Sounds	Autism iHelp – Home
Type	An application used by normal and special needs kids	Mobile	Mobile
Similar app features	Allows the child to play instruments virtually Allows to listen to audio and respond	Auditory representations learning activities are presented in a game format photos chosen to increase the child's ability to grasp the concepts.	Includes common household used for requesting or used as a communication aid. Option to have images presented at random or not for concrete learning. Audio to provide the realistic experience for the child.

			Learning activities are presented in a game format photos chosen to increase the child's ability to grasp the concepts.
Name of the app	proloquo2go	Otsimo	CommBoards Lite
Type	Mobile	Mobile	Mobile
Similar app features	Designed for people who are nonverbal. It promotes language development and allows people to communicate using pictures.	Provides personalized games for behavioral development Helps in verbal communication development	Communication assistance method that lets users tap on images, hear sounds and words pronounced aloud.

TABLE II. GAP ANALYSIS OF WEB AND MOBILE APPLICATIONS CONTINUATION

Name of the solution	Autism & Beyond	Autism iHelp – Play	Jade Autism
Type	A study	Mobile	Mobile
Similar app features	For children between 1- 6 years. Child will watch videos while camera captures the response. Survey to be filled by parents measures emotions and head positions.	Option to have images presented at random or not for concrete learning. Audio to provide the realistic experience for the child. Learning activities are presented in a game format Photos chosen to increase the child's ability to grasp the concepts.	Monitor activities by experts & professionals. Simple touch interface. Detailed reports.
Name of the app	Autism iHelp – Comprehension	MITA	Cuedin-Autism Early Intervention
Type	Mobile	Mobile	Mobile
Similar app features	Targets fundamental receptive language skills in a variety of	Contains unlimited cognitive exercises Early	Timely visual cues relieving autistic kids Immediate Real time feedback

	formats. While utilizing real-life photographs Track child's gains through progress reports Include written and verbally presented directions.	intervention Playtime rewards and offline viewing	Voice overs & instructions
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B. Feature Comparison Matrix

Below Table III displays the comparison of the features that has been considered to compare the proposed solution with the similar competitive applications which were found. Along with features for the autistic children and their guardians the proposed solution mainly focuses also on the UI of the application which should be favorable and useable for the affected child.

TABLE III. COMPARISON OF FEATURES IN COMPETITIVE APPLICATIONS WITH THE PROPOSED SOLUTION

Features	MITA	Jade	proloquo2go	Autism & Beyond	Autism iHelp	Cuedin	Otsimo	CommBoards Lite	Monkey Drum	Autmusic
Detect autistic behavior rate in children (7-16 years) using image processing with the facial expressions.										✓
Screening questionnaire			✓							✓
Recommend music types to the autistic kids				✓	✓	✓			✓	✓
Recommend videos for visual disturbance	✓		✓		✓			✓	✓	
Calculate the rate of autistic behaviors-evaluate progress	✓	✓	✓		✓	✓	✓			✓
Guidance through motivational audios and videos		✓	✓							
Allow autistic child to play games – Q&A	✓	✓			✓	✓	✓	✓		✓
User friendly UI/UX	✓		✓	✓	✓	✓	✓	✓	✓	✓
Free download/subscription					✓		✓		✓	✓
UI structure should be simple, clear, and predictable			✓	✓	✓	✓	✓			✓
The text goes with pictures.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Simple and precise language use			✓	✓	✓		✓			✓
Available in multiple languages					✓					
Android platforms	✓				✓		✓	✓		✓
iOS platform	✓		✓		✓		✓		✓	

IV. SOLUTION

An android mobile application platform to diagnose the autism and the individual's autistic rate from age 7-16 through video processing and Autism Spectrum Screening Questionnaire respectively along with a music therapy including a gaming platform for the children to play and track their performance so that their guardians can analyze through their progress to see their performance so that the child will be able to grow independently by developing their communicative and interactive skills.

As mentioned above the solution should not only focus on the features such as the diagnosis of autism using facial recognition, filling questionnaires to identify the range of the autism, recommendation of music through audios to the affected child, allowing affected child to play games to analyze their progress and performance, but also as this solution would be used by an autistic child apart from their parents or the caretakers the UI of the solution should be in favor of the child to support their ability. The UI of the solution will have the following guidelines when developed,

- Design, structure, and language will be simple and clear.
- Clear, easily understandable pictures will be used with redundant representation of information.
- Moving texts, blinking images or texts, background sounds will be avoided.
- Fonts of the texts will be in big font, simple font style and with mild color.
- Will allow user for interaction and customization and navigation will be consistent in every page of the application and each navigation buttons will be either on the top or bottom of the screen.

Through research of the similar applications and sites it is observed that such above features are lacking. Therefore, implementing the proposed solution considering the above feature guidelines will be favorably accessible for ASD users [34].

Due to the user-friendly interface with dark and light mood, ease in error finding and debugging, auto-completion files, and highly efficient results notepad++ will be used to build the proposed solution. While Android studio will be used as the framework as it could render native user interface elements on Android, achieve a high performance, ability to preview the changes in the mobile application, a strong debugging tool and has a reusing code feature. Languages as Java and XML are used in android studio. Java for data process purposes

and as it is an easy to use and an object-oriented programming model it is used for the development while XML is used as it is also a simple and easy to use language, which can be used to set the layout of things like buttons and images, and defines the font, and color [35].

Use of emotion API from Microsoft azure is for implementation of facial recognition process as it is very cheap as the existing compilers can be used for development and use of library to enter data and to receive responses, and relatively easy to simulate and generate result [36], [37]. Language PHP being the easiest scripting language as it is known as the cross-platform language, flexible, also efficient in performance and cost effective which leads to easy integration and compatibility will be used for the backend development of the solution [38], [39]. The MySQL database can be used for wide range of purposes such as e-commerce, data warehousing, and logging applications and as the solution needs to store data of the user & child, child state, progress of the child and the music details, MySQL will be a suitable database management system based on structured query language to be used in building the solution [39], [40].

V. CONCLUSION

The aim of the research is to analyze the problems faced by the ASD individuals and their guardians, and to implement an application to screen autism in individuals from age 7 to 16 using emotion API and ASSQ questionnaire along with that to provide music therapy to help ASD individuals to overcome the lack of communication and interactive skills [41], [42]. The age gap of 7-16 was focused as there are several applications for early diagnosis, while this age gap of children usually undergo autism due to their family surrounding [43], [44] This led the author to design and develop a software solution with not only screening option, and music therapy but also to provide a platform for ASD individuals to track their progress through a game challenge and the research aim is successfully achieved with the Autmusic solution [45].

CONFLICT OF INTEREST

The views and the solution expressed are entirely those of the authors and the authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

Johsual Thiveniya Sathiyamoorthy and Gayashini Shayanka Ratnayake were responsible for the conception of the review. Johsual Thiveniya sathiyamoorthy was responsible on identifying the real-world problem on autism, study conception, data gathering on the other similar solutions around the world, interviews from autistic children and their parents, quality assessments and wrote the first draft of the manuscript. Both authors contributed to and have approved the final manuscript.

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