

A Review on the Application of AI Tools in Improving Speech Therapy Outcomes for Children Diagnosed with Autism Spectrum Disorder (ASD)

Atmadeepa Srimany
MSc Biotechnology
Maulana Abul Kalam Azad
University of Technology
Kolkata, India

Debraj Paul
Assistant Professor
Guru Nanak Institute of
Pharmaceutical Science &
Technology
Kolkata, India

Sagnik Banerjee
MBA in Finance, Institute of
Engineering and Management
Kolkata, India

Abstract:- Artificial Intelligence (AI) has significant applications over speech therapy which has address the severe challenges faced by the children who were diagnosed with autism spectrum disorder (ASD). This review explores the potential of those children to improve their social interactions and communication skills. Diverse literature review of this study has explored the key advancements like automated speech recognition using Machine Learning (ML) and Natural Language Processing (NLP) and offer tailored integration of AI-enabled collaboration.

Keywords:- AI Tools for Speech Therapy, ASD, ML, NLP, Speech Therapy, Speech Recognition Technology.

I. INTRODUCTION

A neurodevelopmental disorder known as autism spectrum disorder (ASD) is typified by difficulties with behaviour, interactions with others, and speech. Substantial language and linguistic deficits are common in children identified as having ASD, which might hinder their capacity for interpersonal navigation and successful communication. Initial and successful language therapy treatments are essential for young kids to have enhanced interaction results. In current times, Artificial Intelligence (AI) is emerging as the most powerful tool in healthcare as it can help recognise patterns, analyse trends via large datasets, and thus provide tailored solutions accordingly [9]. The purpose of the review is to examine information gathered from case studies, clinical trials as well as previous research to determine how these technologies, in contrast to conventional techniques, affect speech therapy results.

II. LITERATURE REVIEW

A. Types of AI application

AI has ensured that innovative speech therapy tools for children suffering from ASD include AI-driven speech recognition systems, NLP and ML-based feedback systems. AI-powered speech recognition technologies evaluate spoken emotions and assist kids with ASD in pronouncing words clearly and correctly. Such systems can identify the

distinct speech habits of a kid, particularly abnormal pitch or pronunciation, and offer customised advice. Tools with NLP capabilities improve communication by comprehending and producing language from user input. Such resources support sentence building, expanding vocabulary, and linguistic subtlety comprehension in kids with ASD [6].

B. AI Tools in Speech Therapy for ASD

An AI-based tool called Talkitt, for example, can interpret incoherent speech and convert it into understandable patterns of speech. Clinical experiments by SpeechAI have demonstrated that it can increase comprehension of speech in children with ASD by 41% [4]. This enables counsellors to develop more specialised treatment programs by better understanding the child's requirements. An AI-based lipreading program called Liopa, for instance, uses visual clues to analyze language and fixes phonetic errors in real-time [5]. This function is especially helpful for non-verbal kids. According to WHO, there are currently 1.3 billion individuals worldwide who use assistive technology; by 2030, this figure might increase to 2 billion. The number of persons with disabilities is continuously increasing [6]. The availability of assistive technology has been recognised as a fundamental human right by the UN Convention on the Rights of Persons with Disabilities (UNCPRD) [8]. In comparison to professional counsellors, AI-based recognition of speech algorithms identified speech abnormalities in kids with ASD with over 87% precision [10]. Children receiving speech therapy receive immediate input from AI systems that use ML techniques. These programs track the child's development over time, adjust to their rate of studying, and offer remedial advice. For instance, the smartphone-based AI-powered SpeakSee detects speech sounds and provides real-time feedback on language modulating and intonation [7].

According to EU-startups.com, (2024), Speaksee has made sure that deaf and hard-of-hearing individuals may take part in participating in group discussions since 2022. Inventor of Speaksee, Jari Hazelebach and his group created an application that transcribes audible words into written text while differentiating across speakers [5]. A tiny microphone with a coloured attachment is given to every

single 1 of the 9 people who can join in the chat. The documents displayed on the deaf or hearing-impaired individual's screen incorporate these colours. Any noise from the surroundings is filtered out throughout this procedure. They can now both follow the discourse and understand who is contributing whatever as a consequence. Research has shown that kids suffering from ASD, who used comparable AI tools showed a 31% quicker development in pronunciation than kids with conventional speech therapies [4].

C. Importance of AI in Speech Therapy

A computer program that mimics intelligent human behaviour is known as AI. AI is quickly changing the healthcare industry. It provides several problem-solving algorithms in our real-life application in the form of ML, deep learning, and generative AI. The medical sector is getting a cost-efficient result, especially using image recognition technology in lung cancer cell detection, speech recognition technology for autistic patients, machine learning in cancer cell detection, and so on. The best feature of AI is producing error-free results with a good accuracy rate. This review focuses on speech-related issues [7]. In society, some humans are suffering from autism; in this case, patients are unable to speak properly. AI is the best option for speech recognition and voice impairment detection. In both the autistic patient and the larger hospital setting, speech or phrase recognition technology may help meet patients' communication demands [2]. It has illustrated the viability of voice or phrase recognition technology for autistic patients with speech impediments using the stage-specific reporting guidelines by DECIDE-AI to provide recommendations for healthcare technologies. Liopa, a software for lipreading, Queen's University Belfast, and Lancashire Teaching Hospitals NHS Foundation Trust have conducted a review regarding this which has been funded by the UK govt. It can be utilized as a portable Android or iOS gadget with internet connectivity [5]. After downloading the program to the devices, each user's first calibrations were finished, guaranteeing adequate visibility through the identification and extraction of their unique lip region [4].

A brief training on using the app was provided to the patients. Patients tried to utter a phrase of their choosing using the list of supported words, which enabled the Speech Recognition for the Voice Impaired (SRAVI) method to produce a list of three potential outcomes arranged from first to third in order of likelihood. By enclosing the face inside the app's highlighted oval face shape, the ideal distance from the camera was established. After that, the patient would either confirm that the appropriate phrase was there among the options or state that it wasn't. During the hiring process, the available phrases were examined and improved based on user input [9]. The following modules are typically found in speech recognition systems: the decoder, the acoustic extraction processing module, the language-associated model, and the acoustic-related model [8]. The link between sequence and hidden state in speech is expressed by the Hidden Markov Model (HMM) [3]. Almost 50% of speech recognition systems will first use HMM before creating an acoustic model [9]. HMM is a probabilistic model mostly

made up of random function HMM and fixed state number HMM. It represents random statistical states and features using parameters [11].

III. METHODOLOGY

A. Search Strategy and Data sources

Key concepts and keywords have been identified. The primary keywords include "autism spectrum disorder", "ASD", "Children with ASD", "Speech Therapy", and "AI-enabled speech therapy". The intervention terms were "Artificial Intelligence", "Natural Language Processing", "Machine Learning", "Speech Recognition Technology". Outcome terms like "Communication improvement", "Language development", "Speech Outcomes". PubMed, ScienceDirect, ClinicalTrials.gov, Google Scholar, WHO, NHS and PsycINFO have been used for different therapeutic interventions on developmental disorders and studies related to communication and speech in ASD.

B. Inclusion and Exclusion Criteria

Research that offers quantifiable or qualitative information about how well AI treatments affect therapy for speech results, such as enhanced verbal exchange, language knowledge, or interpersonal abilities. Only studies written in the English language and published within the last 6 years have been chosen to ensure the relevance of advancements within AI usage.

IV. CHALLENGES AND LIMITATIONS

Bias and accuracy issues may arise in AI or ML models due to insufficient training data and systematic prejudice of the potential results. A voice recognition system may function flawlessly for certain individuals but badly for ASD-affected children with a different regional or non-native dialect, resulting in a notable performance difference.

V. FUTURE POTENTIAL

The demand for speech treatment software has grown significantly in recent years and offers bright future possibilities for ASD-affected children. One of the industries driving this growth is education, which reflects the increasing acceptance and use of speech therapy software in various contexts. As technology continues to progress, such solutions will become increasingly important in helping those who have trouble speaking [12]. Algorithms that use data mining may see minute trends in a child's answers and modify treatments appropriately, improving the strategy in actual time.

VI. RECOMMENDATIONS

In order to simulate conversational therapy, advanced AI models can be used which can reinforce the method of learning and adapt the speech therapy session to the children affected with ASD. Combined audio-visual can help to leverage the emotion recognition process and enable the cross-comparison of AI tool hybrid therapy of concepts [13].

Open-source or low-cost AI solutions must be used to enhance accessibility in underserved regions.

VII. CONCLUSION

Based on the above discussion, it can be summarised that though this review focuses on the basic AI models the emerging multimodal AI is unexplored. AI can offer flexible, stimulating, and customised remedies that cater to the particular communication requirements of kids with ASD by utilising AI, NLP, and multimodal AI technology.

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