NeuroTir: Test, Identify and Revitalize, An AI-Driven Assistance for Neurodevelopmental Disorders.

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Abstract*—Artificial Intelligence has emerged prominent in the field of Neuroscience marking it's significance in supporting neurodevelopmental care. NeuroTIR- Test, Identify and Revitalize functions originated with the motive to perform as an intelligent assistance system which helps people who have neurodevelopmental disorders including ADHD and ASD and Dyslexia. The application uses AI assessment tools together with music frequency therapy to evaluate and identify and improve cognitive and behavioral abilities of neurodiverse people. NeuroTIR combines adaptive screening systems with customized therapeutic approaches to deliver accessible care through it's scalable mobile platform which offers supportive services.*

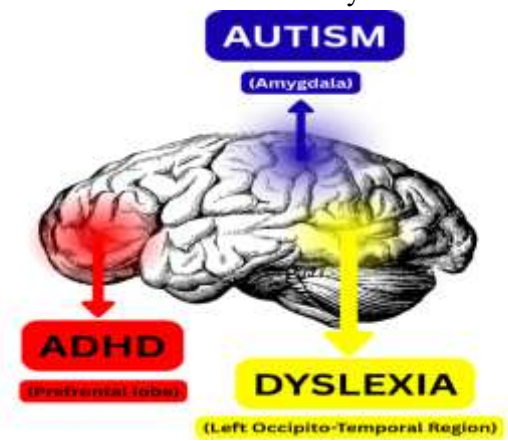
Keywords -------Artificial Intelligence, Neurodevelopmental Disorders, ADHD, Autism Spectrum Disorder, Dyslexia, Music Frequency Therapy, Assistive Technology, Mobile Health Application.

I. INTRODUCTION

NeuroTIR stands for Neuro-Test, Identify and Revitalize. Neurodevelopmental disorders such as ADHD, Autism Spectrum Disorder (ASD), and Dyslexia affect millions of children and adolescents worldwide. Early identification and continuous intervention are critical for improving cognitive, behavioral and social outcomes. Medical facilities need to provide extensive clinical resources to deliver their standard diagnostic and treatment services which prevents many people from receiving care. The path to success for children and teenagers requires two fundamental elements which include early recognition and ongoing active support to achieve social and emotional and academic development.

The current healthcare system presents an unwelcoming situation because patients must wait for extended periods while paying high fees to access limited medical facilities when they follow conventional diagnostic methods and treatment procedures. Many neurodiverse persons fail to obtain assistance because their required support exists in locations they cannot access or at costs which they cannot afford. AI integration with mobile health systems creates a positive solution for this situation. The use of technology enables us to provide screening and support services which become available to all people. AI systems detect minor behavioral changes but music therapy stands out as an effective therapeutic approach which helps neurodiverse individuals develop their ability to concentrate and their emotional control and active participation.
The finished product will evolve into more than a diagnostic tool because it will become Clover which serves as a neuro-bot digital assistant to support neurodiverse individuals in their current home setting.

The NeuroTIR mobile application combines AI-based behavioural assessment with adaptive music therapy which operates through an Android platform. The primary objective of NeuroTIR is to create an accessible digital companion Clover that supports early risk detection and provides ongoing cognitive stimulation in user-friendly environment.



(Figure 1.1 Neurodevelopmental disorders in the selected regions of the brain)

II. RELATED RESEARCH WORK

The intersection of AI and neurodevelopmental support has attracted increasing research attention in recent years. Research interest in the combination of AI systems with neurodevelopmental support services has grown during the past few years. Research scientists have studied ADHD classification through machine learning methods which analyze behavioural questionnaire results together with monitor data from activity devices. The methods achieve moderate to high accuracy which proves that automated risk screening systems function successfully. AI-based autism screening systems which use gaze tracking and facial expression analysis and behavioural scoring techniques have proven to be effective diagnostic tools.

Researchers have conducted numerous studies to assess music therapy as a safe treatment method which helps neurodiverse people without using medical interventions. Research indicates that structured auditory stimulation can positively influence neural plasticity, attention span, and emotional regulation. The brainwave-based frequency approaches have demonstrated potential to help people maintain focus while achieving relaxation states.
Mobile health applications have expanded assistive technology accessibility because they enable users to monitor remotely while receiving therapeutic services at home. The current applications face three main problems because they cannot adapt easily and they do not combine smart features and they lack effective personalized options. Most platforms treat screening and therapy as separate processes rather than components of a continuous feedback loop.

NeuroTIR maintains its uniqueness through an AI-based system which produces identification results that directly create personalized treatment solutions. The unified system obtains better engagement results and performance through its mobile-first solution which preserves system accessibility features.

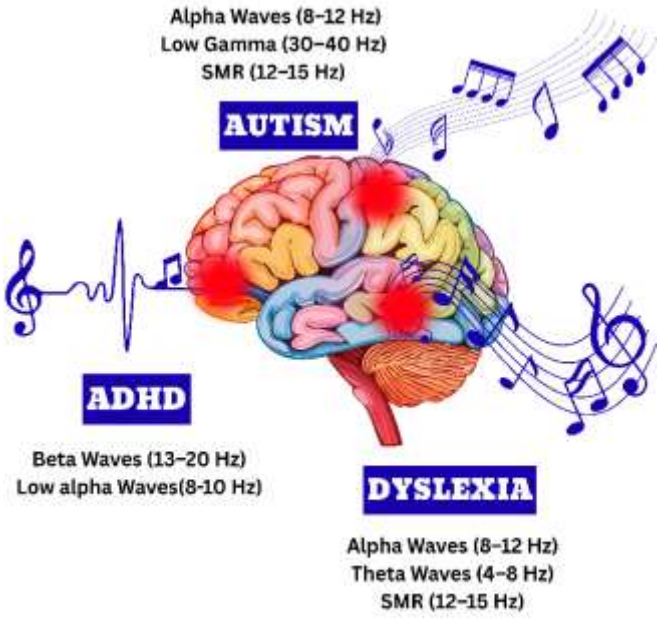
III. PROPOSED SYSTEM

The NeuroTIR framework functions as a complete assistive system which aids users during their assessment phase and their analysis stage and their intervention process and their progress tracking activities. The system architecture emphasizes modularity, scalability and user-centric interaction.

The Test module begins its work by gathering behavioral and cognitive information through mobile applications which deliver both structured questionnaires and gamified mini-assessments. The system enables children to operate the interface while it automatically records essential performance metrics which track their response timing and their exactness in task completion and their ability to maintain concentration.

Machine learning algorithms process the collected data within the Identify module to determine the user's behavioral pattern. The model generates risk probability outputs which apply to all supported neurodevelopmental categories. The system functions as a smart screening tool which identifies potential problem areas instead of performing diagnostic functions.

Following identification, the Revitalize module generates a personalized music frequency therapy plan. The therapy engine maps user profiles to specific auditory frequency bands associated with cognitive objectives such as focus enhancement, relaxation, or emotional stabilization. The therapeutic content is delivered through an integrated audio player within the mobile application.



(Figure 3.1 Neurodevelopmental disorders in the selected regions of the brain)

A cloud-backed data layer maintains user history and supports longitudinal progress tracking. The system

operates through an unending feedback system which enables recommendation improvement while displaying user interaction data to caregivers for monitoring purposes.

IV. METHODOLOGY

The NeuroTIR system operates through a methodological framework which unites data collection with data preparation and model building and therapy selection. The process of gathering behavioral information requires users to submit self-reported data while their caregivers help them complete questionnaires and they perform mini-games to demonstrate their abilities. The combination of these sources delivers a comprehensive view of how users behave across various dimensions.

Raw data undergoes preprocessing to ensure quality and consistency. The process of handling missing data involves suitable imputation methods while numerical features undergo normalization to achieve standardized measurement levels. The process of model compatibility requires categorical variables to get encoded and noise reduction methods help reduce the impact of outliers in the data.

Multiple supervised learning algorithms were experimentally evaluated, including Support Vector Machines, Logistic Regression, Random Forest classifiers, and shallow neural networks. The Random Forest model demonstrated the best stability between accuracy and interpretability and robustness metrics according to the comparative analysis results. The system's ensemble structure successfully identified the complex nonlinear behavioral patterns which existed in the dataset.

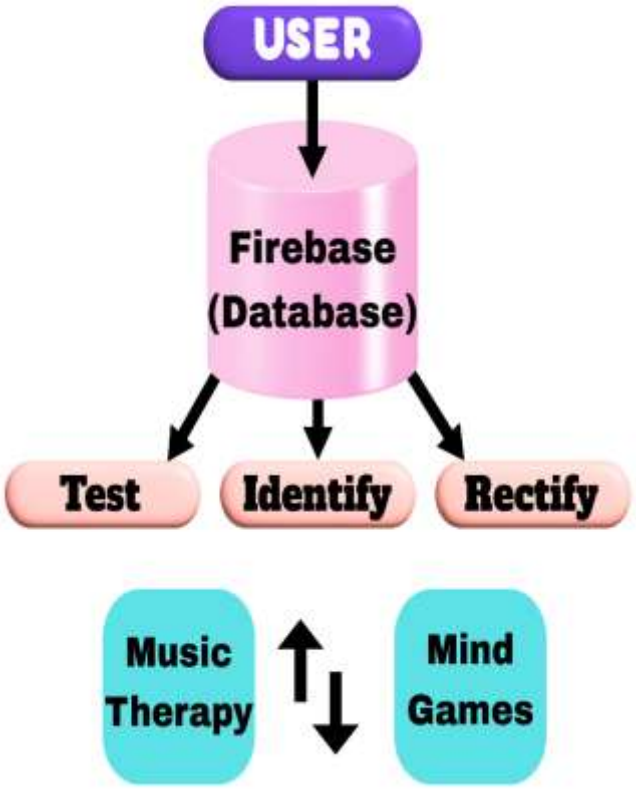
The revitalization strategy is grounded in established brainwave research. The selection of frequency bands which includes alpha and beta and theta enables researchers to focus on particular mental states during their studies. The personalization engine uses three main factors to create therapy playlists which include user age and predicted risk profile and behavioral indicators. The mapping system adapts to different contexts to deliver therapeutic services which maintain their specificity instead of using common treatment methods.

The design focused on three main elements which included simple visual elements and directed user paths and basic mental processing requirements.

V. IMPLEMENTATION

NeuroTIR implementation used a combined system which integrated mobile technology with cloud solutions and machine learning systems. The front-end application was developed in Android Studio using modern Material Design principles to ensure responsiveness and accessibility. The developers used Python-based frameworks which included TensorFlow and Scikit-learn to build and test their models.

Firebase services were employed for secure authentication, real-time database storage, and cloud synchronization. The mobile client connects with the AI inference engine through RESTful APIs which enable their communication. The therapeutic audio module enables users to listen to audio content when they do not have an internet connection through its offline playback functionality.



(Figure 5.1 Working pipeline of the mobile app model system)

The system executes a defined pipeline during its operational phase. User interactions generate feature vectors that are transmitted to the prediction engine. The trained model computes a risk estimation, which then triggers the therapy personalization module. Progress metrics are continuously logged, enabling

both short-term feedback and long-term trend analysis.

VI. RESULTS AND DISCUSSION

Experimental evaluation demonstrated that the Random Forest classifier achieved strong predictive performance, with overall accuracy exceeding ninety percent on the validation dataset. The model demonstrates equal proficiency in classification because its precision and recall scores show it can detect risk patterns without generating many false positive results.

User engagement analysis revealed that personalized music therapy sessions resulted in longer interaction durations compared to static audio content. The therapy users showed better acceptance of their treatment when the caregivers modified therapy suggestions according to the patients' performance results.

Despite these encouraging outcomes, certain limitations must be acknowledged. The current dataset size, while sufficient for prototype validation, requires expansion through clinical collaboration to ensure broader generalizability. The therapeutic results will show variation between patients because each person reacts to sound differently. NeuroTIR functions as a screening and engagement system which supports clinical evaluation but does not replace professional medical diagnosis.

VII. FUTURE WORK

The upcoming development phase will establish multimodal intelligence capabilities and clinical integration systems as its primary focus. The planned system upgrades will include computer vision-based real-time emotion detection and users will have the choice to add EEG or wearable sensors for physiological monitoring and reinforcement learning methods will enhance therapy customization during ongoing treatment.

The project will develop multicultural language support to make the system available worldwide while creating a specific dashboard for clinicians to monitor patient progress under their supervision. The evidence base for NeuroTIR effectiveness will be backed by large-scale clinical validation studies which will be conducted in the future.

VIII. CONCLUSION

NeuroTIR has developed a complete assistive system which uses artificial intelligence to help people with neurodevelopmental disorders by combining smart evaluation methods with customized music therapy based on frequency patterns. The system resolves major accessibility and scalability problems which exist in conventional healthcare delivery systems through its assessment and treatment integration within a single mobile platform. Experimental findings demonstrate promising predictive capability and strong user engagement potential. NeuroTIR will develop into an essential digital support system for neurodevelopmental healthcare through its ongoing process of expanding data sets and clinical testing and flexible system optimization.

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