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ARTIFICIAL INTELLIGENCE BASED EMOTION DETECTION FOR KIDS WITH AUTISM USING MATLAB

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ABSTRACT

Smart monitoring and assisted living systems for cognitive health assessment play a central role in assessing individuals' health conditions. Autistic children suffer from some difficulties, including social skills, repetitive behaviors, speech, and nonverbal communication, and accommodating to the environment around them. Dealing with autistic children is a serious public health problem as it is hard to determine what they feel with a lack of emotional and cognitive ability. Currently, no medical treatments have been shown to cure autistic children, with most of the social assistive research to date focusing on Autism Spectrum Disorder (ASD) without suggesting a real treatment. In this paper, we focus on improving cognitive ability and daily living skills and maximizing the ability of the autistic child to function and participate positively in the community. Through utilizing intelligent systems based Artificial Intelligence (AI) and Internet of Things (IoT) technologies, we facilitate the process of adaptation to the world around autistic children. To this end, we propose an AI-enabled IoT system embodied in a sensor for measuring the heart rate to predict the child's state and then sending the state to the guardian with the feelings and expected behavior of the child via a mobile application. Further, the system can provide a new virtual environment to help the child to be capable of improving eye contact with other people. This way is represented in pictures of these persons in 3D models that break this child's fear barrier. The system follows strategies focused on social communication skill development, particularly at young ages, to be more interactive with others.

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1. INTRODUCTION

ASD is a common word that refers to a category of individuals who have neurodevelopmental brain disorders. Its characteristics include difficulty with social interaction, including verbal and nonverbal communication, repetitive activity, and sensory issues defined differently [1]. Common to all cultural, socio-economic, and racial classes, medicine is unable to fathom the actual cause of this disorder. According to a 2018 Centre for Disease Control and Prevention (CDC) report, there is a 15% rise in the autism prevalence rate, based on a 2014 study of existing research records. Studies indicate a jump in the worldwide number of children with ASD. There are nearly about 2 million children with ASD in India, most between the ages of two and nine. An International Clinical Epidemiology Network (INCLEN) study in India shows the prevalence rate of ASD as 1 in 125 children aged 3 to 6 and 1 in 85 children aged 6 to 9. These children experience multiple disabilities regarding social relationships and cognitive functions and typically exhibit limited, repetitive, and stereotyped behaviors [2].

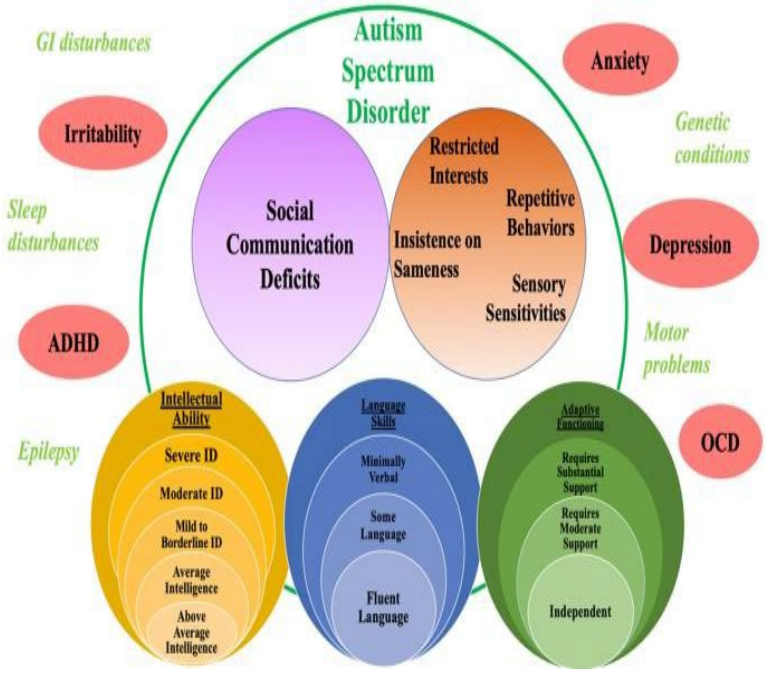

Figure 1. The criteria of various dysfunctions in children with ASD.

Behaviors such as these adversely impact the process of socializing with peers, leading to sudden violent outbursts, aggressiveness, self-hitting, and meltdowns [3]. Such children gradually adapt to their daily routines by being given regular occupational therapy, speech therapy for communication, yoga, and assorted physical activity. Nevertheless, intense emotional outbursts are frequent, and such insistent behavior persists in children with ASD, brought on by sudden hyper-reactivity to sensory stimuli like pain, heat, cold, unusual sounds, touch, odor, taste, lighting, and sensing miscellaneous objects [4].

2. PROBLEM STATEMENT

Children with ASD fall into a highly diversified category, displaying a broad variety of behavioral responses and hampered emotion recognition. They lack a "theory of mind," alongside an inability that manifests itself in a struggle to perceive emotion in the people they interact with and in regard to coming to terms with their own emotions [5]. Given that such children have trouble developing and maintaining age-appropriate relationships, they cannot adjust to differing social settings, hindering imaginative play and building new friendships. A unique and personalized piece of technology, harnessed by a system with suitable mechanisms, can help meet the needs of children with ASD [6]. Developing a system that instantly identifies the mental status of children with ASD and warns their caretakers/occupational therapists/psychiatrists of an impending, though unexpected, emotional outburst or temper tantrum will go a long way in preventing extreme behaviors from happening. Researchers have worked on measures from behaviors like facial expressions, speech, and gestures to comprehend the psychological behavior of persons with and without special needs [7]. These methods, however, depend on the external behavior of the subjects in question and can by no means interpret their true socially masked or unexpressed internal state. Their emotions are often misunderstood, leading to loneliness and depression. This is where physiological signal-based emotion recognition, from a slew of findings, helps detect internal emotional states in children with ASD and persons who successfully mask their emotions in different social settings [8].

3. OBJECTIVE

This thesis aims to address the problem mentioned in the above section in children with ASD by proposing a novel method of emotion recognition using ECG signals. The main objective of our project is to develop an AI-based kit to detect the child's emotional state and Look for the best way to know the person's state. So, we chose an EEG sensor because it is easy, accurate, and practical to use.

4. JUSTIFICATION

The approach in this work enables automatic emotion recognition in children with ASD, who suffer from an inability to express emotion, resulting in sudden temper tantrums and explosive outbursts [9]. The onset of these sudden emotional outbursts is repetitive and destructive and is a problem often reported by caretakers, doctors, and therapists of patients with ASD. This study does not include trials on very young children under 5. Thus, to address the problem discussed above, this thesis intends to design a personalized emotion elicitation protocol and test the feasibility of the appropriate methodology in terms of its ability to recognize emotional states in children (aged 5 to 12 years) in typically developed children and children with ASD [10]. A system that sounds the alarm at the onset of a harmful emotional disturbance at its very inception will help therapists, caretakers, and doctors automatically understand a child's underlying emotional state, apart from being most helpful in providing much-needed medication and therapy, thereby helping avert intense emotional outbursts [11].

5. LITERATURE REVIEW

In recent years, wearable devices such as smartwatches and intelligent belts for tracking health and related parameters have been increasingly introduced [12]. Researchers in HCI use such devices to categorize a user's hidden emotional state by acquiring physiological data as well as observable behavioral information (posture, expression, and behavior levels) to assess the user's mental and emotional states such as stress, drowsiness, happiness, sadness, disgust, fear, and surprise, that are mapped to the acquired physiological data using the various machine learning algorithms [13]. Emotional regulation in children with ASD triggers severe emotional distress that shows up in the form of frequent temper tantrums, screaming, sudden mood swings, and anger when expectations are not quickly met. Strategies for emotion regulation are tailored to address the child's needs by analyzing behavioral habits and developing an effective assistance mechanism, with no clue about the child's underlying internal emotional problems. Intervention includes the development of personalized preventive and corrective measures that center around understanding how the child identifies and experiences the different circumstances that engender emotion [14].

This chapter has reviewed the modalities and approaches researchers use to build a bio-signal-based system that identifies emotion in persons with ASD and a typically developed group. Given that the behavioral patterns and expressions of children with ASD and other syndromes are not entirely reliable and change from time to time, their underlying states can be best observed using physiological signals. Accessibility to non-intrusive and wearable sensors helps obtain physiological data without too much difficulty [15]. Physiological signals, in addition to helping children with ASD understand their emotions, also assist their caregivers in understanding what these children are feeling at a particular time. There is, thus, a need to devise a mechanism that comprises a biofeedback system to help children with ASD come to terms with their emotional states. The drawback of earlier systems is their need for a post-storage analysis [16]. Although biosignal measurements from the EEG, ECG, PPG, RR, and EMG are immensely helpful in determining the emotions of children with ASD, placing electrodes with wires on different parts of the body like the scalp, facial muscles, chest, wrist, hands, and legs is likely to cause the children discomfort, owing to sensory issues. When the number of subjects is high, it is also challenging to detect features [17]. As a result, a non-invasive, non-intrusive, authentic, realistic, and secure method of monitoring and alerting caregivers for children with ASD must be produced. Such a process calls for a successful transition from a lab to its implementation in the real world so as to be able to help persons with similar infirmities as well [18].

The various methods and algorithms involved in removing the artifacts from the raw ECG signal and also about the algorithms and formulas that derive the time, frequency, and time-frequency domain, statistical, nonlinear, energy-based features using FFT, DWT, and HHT-based algorithms [24]. Using the DWT Daubechies (db4) mother wavelet, the baseline wandering was effectively removed, and high-frequency noises due to excessive movement of the child were removed using the butter worth low pass filter. In this work, nearly 42 features were extracted using FFT, DWT, and HHT-based algorithms. The classification of the derived features is classified using the KNN and ensemble classifier which is explained in detail.

The Normalized ECG signal, HRV, and QRS data were statistically analyzed using the ANOVA, and the selected features extracted were classified using the KNN and ensemble learners. It was observed that the derived HRV signal without any transforms captured the emotional information better than the ECG and the QRS amplitude by obtaining an overall maximum average accuracy of 84.8% and 75.3% in typically developed children and children with ASD. A similar analysis was done to validate extracted features from the time and frequency domain transformed signals ECG, HRV, and QRS using three algorithms (FFT, DWT, and HHT), and only the selected features were used for classification.

It was inferred that the HHT of ECG conveyed the Emotion information more effectively than the DWT and FFT algorithms. The overall maximum average accuracy for HHT of ECG was found to be 75% and 81% for typically developed children and children with ASD. The subject-independent analysis was done by fusion of features from three algorithms of typically developed children and children with ASD; again, the HHT of ECG was better than the other two algorithms by achieving an overall accuracy of 75% (typically developed) using an ensemble classifier. In Fig. 2, We developed a kit using Arduino ide, MATLAB, and EEG sensor to detect the emotion of the kid, and added to that, we provide a relaxing solution based on the emotion state.

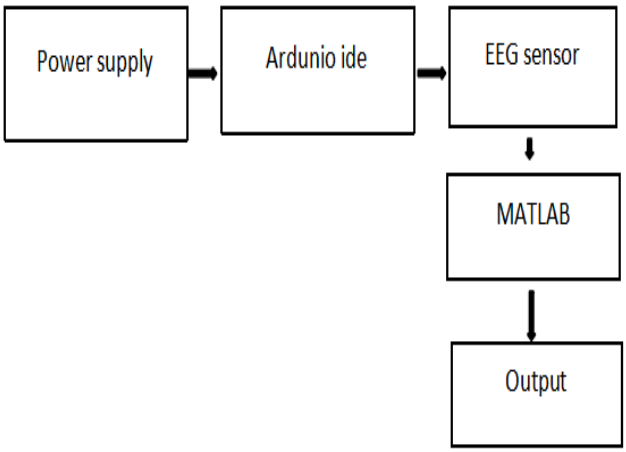

Fig. 2. System Architecture

An electroencephalogram (EEG) is a test that measures electrical activity in the brain using small metal discs (electrodes) attached to the scalp, as shown in Fig. 3. Brain cells communicate via electrical impulses. They are active all the time, even during sleep. This activity shows up as wavy lines on an EEG recording.

Fig. 3. EEG SENSOR

Emotional states obtained from the typically developed group and the children with ASD using ECG signals showed varying outcomes. The pre-processing results obtained from the corrupted raw ECG signal were addressed in the first part of this chapter, and the performance of different digital filters was compared using their performance measures, and the best-suited filter was selected. The experimental results of subject-dependent and subject-independent analysis of two emotional states using the filtered ECG, HRV, and QRS complex in typically developed children and children with ASD were compared in the second part of this chapter. Also, the performance of FFT, DWT, and HHT of ECG, HRV, and QRS signals were compared using the machine learning algorithms.

6. CONCLUSION

In this project, we detect the patient's emotional state using an Arduino IDE EEG sensor. First, we analyze the patient's mood, like sad, happy, tired, and sleepy. The sensor will give the value of HUE, contrast, color enable, etc. In this article, we proposed an intelligent system with AI-enabled Internet of Things to help the autistic child adapt to the surrounding environment by determining the child's emotional state through a sensor that reads the child's brain waves and is classified by MATLAB software. The proposed system attempts to obtain emotional feelings in a group of autistic children by analyzing EEG sensors before, during, and after challenging behaviors.

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ETHICAL APPROVAL

Nil

COMPETING INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Krupa N, Anantharam K, Sanker M, Datta S, Sagar JV. Recognition of emotions in autistic children using physiological signals. Health Technol (Berl) 2016;6:137–47. https://doi.org/10.1007/s12553-016-0129-3.

[2] Elsabbagh M, Divan G, Koh YJ, Kim YS, Kauchali S, Marcín C, et al. Global Prevalence of Autism and Other Pervasive Developmental Disorders. Autism Res 2012;5:160–79. https://doi.org/10.1002/aur.239.

[3] Krishnamurthy V. A clinical experience of autism in India. J Dev Behav Pediatr 2008;29:331. https://doi.org/10.1097/DBP.0b013e3181829f1f.

[4] Monica Juneja Smitha Sairam. Autism Spectrum Disorder-An Indian Perspective. Recent Adv Autism 2018:1–15.

[5] Chiarotti F, Venerosi A. Epidemiology of utism pectrum isorders : Review of Worldwide Prevalence Estimates Since 2014 2020. https://doi.org/10.3390/brainsci10050274.

[6] Bal E, Harden E, Lamb D, Van Hecke AV, Denver JW, Porges SW. Emotion recognition in children with autism spectrum disorders: Relations to eye gaze and autonomic state. J Autism Dev Disord 2010;40:358–70. https://doi.org/10.1007/s10803-009-0884-3.

[7] Moskowitz LJ, Mulder E, Walsh CE, McLaughlin DM, Zarcone JR, Proudfit GH, et al. A multimethod assessment of anxiety and problem behavior in children with autism spectrum disorders and intellectual disability. Am J Intellect Dev Disabil 2013;118:419–34.

[8] A. R. Javed, L. G. Fahad, A. A. Farhan, and S. G. R. M. M. S. Abbas, “Automated cognitive health assessment in smart homes using machine learning,” Sustainable Cities and Society, vol. 65, p. 102572, Article ID 102572, 2021.

[9] H. Mughal, A. R. Javed, M. Rizwan, A. S. Almadhor, and N. Kryvinska, “Parkinson’s disease management via wearable sensors: a systematic review,” IEEE Access, vol. 10, pp. 35219–35237, 2022.

[10] L. J. Baptist Andrews, L. Raja, and S. Sundaram Suresh, “Mhealth applications providing a way through community development and its necessity,” Journal of Computational and 8eoretical Nanoscience, vol. 18, no. 3, pp. 850–856, 2021

[11] M. Rizwan, A. Shabbir, A. R. Javed, and M. T. D. Shabbir, “Brain tumor and glioma grade classification using Gaussian convolutional neural network,” IEEE Access, vol. 10, pp. 29731–29740, 2022.

[12] E. H. Houssein, D. S. Abdelminaam, I. E. Ibrahim, M. Hassaballah, and Y. M. Wazery, “A hybrid heartbeats classification approach based on marine predators algorithm and convolution neural networks,” IEEE Access, vol. 9, pp. 86194–86206, 2021.

[13] Lin I, Yamada T, Komine Y, Kato N, Kato M. Vocal Identity Recognition in Autism Spectrum Disorder. PLoS One 2015;10:1–10. https://doi.org/10.1371/journal.pone.0129451.

[14] White SW, Maddox BB, Panneton RK. Fear of Negative Evaluation Influences Eye Gaze in Adolescents with Autism Spectrum Disorder : A Pilot Study 2015. https://doi.org/10.1007/s10803-014-2349-6.

[15] Kwon O, Jeong J, Kim H Bin. Electrocardiogram Sampling Frequency Range Acceptable for Heart Rate Variability Analysis 2018;24:198–206.

[16] Butterworth C. Filter approximation theory. Engineer 1930;7:536–41.

[17] N. Huang, Z. Shen, S. Long, M. Wu, H. H. Shih, N. C. Yen, C. Tung and HL. The empirical mode decomposition and the Hilbert spectrum for nonlinear and non-stationary time series analysis. Proc R Soc London 1998;454:903–95.

[18] Dyson M, Balli T, Gan JQ, Sepulveda F, Palaniappan R. Approximate Entropy for EEG-based Movement Detection n.d.:1–6.
[19] Sprott JC. Chaos and Time-Series Analysis 2003.
[20] Saravanan KM, Selvaraj S. Performance of secondary structure prediction methods on proteins containing structurally ambivalent sequence fragments. Peptide Science. 2013;100:148-53.
[21] Imandoust SB, Bolandraftar M. Application of K-Nearest Neighbor (KNN) Approach for Predicting Economic Events : Theoretical Background. Int J Eng Res Appl 2013;3:605–10.
[22] Thayer JF, Brosschot JF. Psychosomatics and psychopathology: Looking up and down from the brain. Psychoneuroendocrinology 2005;30:1050–8. https://doi.org/10.1016/j.psyneuen.2005.04.014.
[23] Saravanan KM, Zhang H, Hossain MT, Reza MS, Wei Y. Deep learning-based drug screening for COVID-19 and case studies. In Silico Modeling of Drugs Against Coronaviruses: Computational Tools and Protocols. 2021:631-60.
[24] Lory C, Kadlaskar G, Mcnally R, Alexander K, Brandon LF, Lory C. Brief Report : Reduced Heart Rate Variability in Children with Autism Spectrum Disorder. J Autism Dev Disord 2020:1–8. https://doi.org/10.1007/s10803-020- 04458-8.