

Analysis of Autism Spectral Disorder

Kirubha.M¹, Aiyaswarya.S², Pavithra.M³, Prinitha.R⁴

¹Assistant Professor, Department of CSE, Sri Ramakrishna Institute of Technology,

^{2,3,4}Students, Department of CSE & IT, Sri Ramakrishna Institute of Technology,
Coimbatore, Tamil Nadu, India

¹Kirubhamurugan93@gmail.com, ²msaishu1999@gmail.com, ³pavithramoorthy2799@gmail.com,

⁴prinitharengasamy@gmail.com

Abstract: Autism is a serious development disorder that blunts the ability to communicate and collaborate. It is specifically known as Autism Spectrum Disorder (ASD) which affects the nervous system and also the overall cognitive, emotional, social and physical health of the affected individuals. Some of the symptoms are compulsive behaviours, impulsivity, improper social interaction, intense interest in a limited number of things, depression or unaware of others feelings, anxiety, change in voice sensitivity to sound. Treatment consists of therapy, early recognition as well as behavioural, education and family therapies may reduce the symptoms and also support development and learning. They determine a machine learning approach that uses wearable data to discriminate physiological states combine with stressful and non-stressful scheme in child with ADS. Kalman filter method is used to find the integrate heart beat rate and accelerometer signal. They monitor the affected child and collect data based on their activity by using wearable sensor. Wearable may be of belts, badge and watches that are hooked to the children or adults with Autism disorder. Therefore this wearable system is used for the user to recognize speech and also help in their regular activities.

Key words: Autism Spectrum Disorder (ASD), Kalman filter method, heart beat rate, accelerometer signal.

1. INTRODUCTION

Autism refers to wide range of action that is characterized by provocation with social skill, heredity behaviours, speech and non-verbal communication. Autism is specifically known as Autism Spectrum Disorder (ASD). Admit to the centres for disease control autism affects an estimated one in forth of the children. ASD is a negligible problem or ailment that needs full time care with special facility. Autism affected children have difficulties with communication and understanding what others think and feel. This makes them tough to express oneself either with words or through gestures, facial expression and touch. Some of the symptoms are lag in spoken language, monotonous use of language and actions which includes hand flapping, whirling objects etc. lack of eye contact, not wanting to be held or snuggled, being overly focused on one item, loss of concern in social contact and social withdrawal, they always prefer to be alone, they don't understand any emotions. We cannot cure autism disorder but they can be treated. The treatment depends upon the child which includes mild and severe symptoms. It includes different types of therapies to improve speech and behaviour.

All the time (24/7) the autism children cannot be watched or taken care of. So the invention of wearable's and tools which helped them came into existence.

2. LITERATURE SURVEY

SuminHelen Kooet.al., propose that the wearable technologies have capability to improve the standard of life and well being of ASD affected children. ASD is an enlightening emotional and behavioural disorder which is characterize by the shortfall in social interaction and communication[1]. The design factors for the Wearable Technology (WT) include safety, data accuracy, amenity, flexible material, manoeuvrability, unique design. In addition to this WT, Wearable Products for autism were inspected through an online searching tool. The first type of helpful technology for calming and alleviating for ASD is clothing. The second type includes wearer's consciousness and helps handle their behaviours. This type of aid expedite is improving communication. ASD favour to use WT that could audit body signals such as heart beat, respiration. Based on the survey the most favour item is accessories. Thus the prototype was developed. As a wearable fabric to allow user to wear it always. To overcome the disadvantages of Wrist band

and ring type sensor a thin and well fitted glove was matured. The working mechanism involves a voltage under 1.5 volts is given across a conductive pads and the resistance is deliberated using Wheatstone bridge circuit which includes resistors differential amplifiers and Buffer. It uses up pulse oximeter to quota HR and HRV. They research identified consumers preferred for WT for ASD. WT as the probability to decrease care liability, boost aspect of life and wellbeing of ASD and their family.

Tianyan Zhou et.al., Describes many methods to improve the act of autism children in terms of speaker diarization system in real life audio data. The children speech is cached from signal channel and they are fed into wearable devices, in real environment is used to collect daily audio recording. First Generalized Likelihood Ratio (GLR) distance with Agglomerative Hierarchical Clustering (AHC) frame work using the Line Spectral Pair (LSP) based GLR distance is processed. They further come up with weighted summation of multiple GLR distance connecting LSP, pitch, energy and phoneme duration information together. Secondly they extract children speech and further analyze the speech. Statistic of speakers, starting and stopping time stamps are identified by the system. At first the VAD (voice activity reduction) is reduced and given to speaker segmentation. After the VAD conduct, the audio data is partitioned into multiple separate speak segment. The spitted segment is further divided into several fragments according to recognized changing point. This biography says various features including Mel Frequency Cepstral Coefficient (MFCC), Perceptual Linear Prediction (PLP) and combination of distinctive features. The GLR distance in clustering stage is used. Organization of chunks from same speaker is mail y focused by Speaker Clustering or Hierarchical Clustering focus at grouping the fragments from same speaker. According to the initial number of clusters it is classified into two categories. The first one is AHC (Agglomerative Hierarchical Clustering) and second one is DHC (Divisive Hierarchical Clustering). They extract the pitch frame by frame during clustering stage. Every fragment contains zero pitch frames and their value can be denoted by a one dimensional pitch vector[2]. These vector used in mixed GLR distance calculation. In the clustering stage they also extract energy frame by frame and one dimensional vector is gathered from every small fragment. A Part of the distance measurement also include energy vector. In this stage they have consolidated thousands of speech fragments into finite number of chunks related to different speaker. Thus they introduce a speaker

diarization system designed for autism children for real life audio data. They combine pitch, energy and phoneme duration feature to better distinguish speech between children's and adults during the chunk stage. GLR distance calculation is used to detect the automatic estimation of contribution weight for each feature and more effectively using the child voice's prior knowledge.

Min-Chun Tuan et.al., Specifies that a competent Micro Control Unit (MCU) model is proposed for wearable electronics and wireless sensor networks. Homecare service and remote healthcare widely employs Wearable electronics and wireless body sensor networks. Without influencing the routine life of patients the wearable electronics and wireless sensor networks give an competent instrumentation and measurement to audit body signals. The proposed wearable electronics and wireless sensor network systems add image sensors and processor for the applications of special education, autism children assistance and healthcare. The proposed MCU design was incorporate by a 0.18-3m CMOS process and it can operate at 100-MHz processing rate. The application of MCU for wearable electronics and wireless sensor networks are not limited in body signals. They develop an efficient micro-control-unit which has been proposed to develop a high-performance, high-security, and low-power-consumption wearable electronics and wireless sensor networks systems. This design has benefits of more functions, higher performance, and higher security for wearable electronics and wireless sensor network application than the previous design [3]. In future works, the research team will develop more potential and useful functions into the proposed MCU design.

Fauzia Fazana et.al., Says that wearable technologies for children with ASD use the Augmentative and Alternative Communication (AAC) solutions as part of assistive. The communication skills and health monitoring of children diagnosed with ASD has been improved by the come up technologies. Communication tool that contentment the conditions analogous to momentous speaking difficulties is an AAC device. They are categorized as unaided and aided AAC devices. Eye contact, facial expression, body language, gestures and manual signs are the defects in children with ASD may also express themselves by using unaided AAC device. High or low technology devices are the further categories of aided AAC. Communication books, Picture Exchange Communication Systems (PECS) and picture communication symbols while high technology devices assimilate iPods, tablets, mobile phones, desktop computers and speech generating devices are the low technological devices. Global Positioning

System (GPS) technology is used to solve behaviour problems of the children with ASD. Tiny sensors implanted on different parts of the body of the children that are the parts of Wireless Body Area Networks (WBANs) technology which is used to observe physiological parameters/signals from different body organs, body motions of children with ASD.[4]. Communicating effectively with other people, carrying out their routine activities in a timely manner is done with the help of this technology. The essence affair functions of the wearable device will assist children with speech disability, wandering problems, and health issues incorporating these key functional requirements from existing devices into one comprehensive solution.

Yan Shi et.al., Propose the development on wearable IOT system that is used to gather the data about the interaction among the autism disorder people. The main objective is to perform the therapy, data driven detection, intervention and also monitor the children. They specify that this principle need through a wearable sensor system which can provide real-time perceptible data about associate interaction in classroom. In early days observation methods are used. But unfortunately observation methods are time consuming. Now-a-days many technologies have been emerged such as LENA system which gives the information about language development. An advanced wearable system to measure pair-wise human interaction between each and every person is modelled. This look like a nametag-sized sensor badge this badge is used to monitor the amount of time two person faces, physical distance between those two person and also their activity level. Ultrasound sonar is used to measure these differences between two individuals. This type of badge is placed in the t-shirt of the children. Hence they summarize that this wearable device is used to detect the activity of children accurately in a preschool classroom[5].

Scott M.Robertsonet.al., Specifies a wearable PDA for adults those who have the autism spectrum disorder. PDA is a light weight device which is impoverished to the wrists of the user. The user mesh with PDA through pen input and short voice commands. This PDA is designed for high functioning adults with autism in daily interaction. It is difficult for the adult with autism to follow certain social rules and norms that how should people behave for some particular situation[6]. Hence this PAD is used to provide a planner module that help them in managing their schedules free time and also organize regular activities. In communication and sensory processing it helps the adults with autism to communicate with people easily. PAD communication module provides

a high degree of structure and employs visual aids in form of text. Hence it describes the use of PAD in form of communication and also provides a planner module for the adult with autism spectrum disorder.

Cheol-Hong Minet.al., Propose the framework to record, detect and label the behavioural patterns of children with autism. The whole system is inbuilt with two different sensors which are wearable and static. The system is said to be wearable based on accelerometer which is used to detect patterns of a subject [7]. The system is said to be static sensor that are microphones and cameras which capture the sounds, images and videos of the children within the room. To extract the features time frequency method is used. For analyzing the accelerometer signal Hidden Markov Model (HMM) is used. By using this method they can achieve 91.5% of classification rate for behavioural patterns. Hence the overall activities of autism affected children and their repetitive behaviour are noted using wearable wireless accelerometer sensor and audio/video sensor. By using the combination of different sensor process, burden for the therapists may become lesser and also provide more information based on self-stimulatory patterns for autistic children.

Aaron J. Masinoet.al., Specifies that individual with autism spectrum disorder have challenging behaviours anticipate by physiological changes. Changes in wearable device data are detected using some methodological devices [8]. To differentiate physiological states combine with stressful and non-stressful scheme in child with ADS uses machine learning approach in wearable data has been demonstrated to overcome the existing technologies . The heart rate and RR interval analysis are collected in the process during activities designed mime stress using a consumer grade and rest in wearable device. Their measurement includes 38 members that are 22 ADS and 16 non-ADS. The following aberration removal, they extract 20 analytical from data collection during every patient stressful period and rest period. They qualified and calculate Logistical Regression (LR) and also Support Vector Machine (SVM) classifiers to label each validation as a stressful or rest period. The LR and SVM models attain 93% and 87% accuracy respectively. Hence machine learning model is merged with wearable data that may support real-time m-health intervention application.

AzadehKushkiet.al., Describes that anxiety combined with physiological changes that can be non noisy which can be deliberated using modest and wearable sensor. These adjustments afford a detached and language free measure of encouragement associated with anxiety, which can complement treatment process for clinical

populations who have struggle with introspection, communication and manic methods for detection of anxiety-related incentive using physiology signals where lots and lots of supervised learning methods have been planned for this purpose. This methodology require legitimate collection and amendment of discipline data and are therefore not suggested for clinical populations where obtaining characterize data may be challenging due to deterioration in communication and introspection. In this situation, the objective of this process is to evolve an unsupervised and real-time arousal detection algorithm. Finally they propose a learning framework based on Kalman filtering theory for the disclosure of physiological arousal based on cardiac activity. The work of the system was appraised on data obtained from a savour of children with ASD (Autism Spectrum Disorder). Hence this process can indicate the anxiety related arousal in children with autism spectrum disorder of 99% and 92%, respectively[9].

Akshaypuli et.al., Says that anxiety is a important clinical in ASD due to its negative brunt based on physical and psychological health. Anxiety medication in ASD reminds a thread due to complication with individual consciousness and conversation of anxiety manifestation. To decrease this problem many treatments, psychological markers are gathered through wearable sensor, has been expected for actual time, ambition and language free measure of anxiety. In real world situations this results in false positive that and hinder these systems. To address this challenge they introducing an approach for real time identification and mitigation of physical activity of children with autism is the main ambition of this wok. Kalman filter method is used to find the integrate heart rate and accelerometer signal[10]. User heart rate under contrasting motion assumption and choosing the correct model for anxiety detection can be tracked using this filter based on user activity condition. The induced method is able to reduce the false detection due to user gesture and effectively detect arousal states during movement periods. Assessment of the algorithm using data that contains samples of children with ASD shows a significant dwindling in false positive compared to the state-of-the-art and the overall arousal identification accuracy of 93%.

Erkita Pittella et.al., Presented a wearable sensor system ingrained in a belt. This belt serves the purpose for monitoring the cardio-respiratory enterprise in children along with neurodevelopment irregularity. Autism has the capability which amends the normal functioning of central nervous system that controls the Heart Rate(HR) [11]. They made use of HR as a useful index of stress

response in children afflicted by ASD. Fluctuation in HR allows identifying and segregating patients into two groups based on the comeback of stressful events. Real-time disclosure of stress requires uninterrupted audit. For this they invented a Bio harness 3.0 which is used to oversee the adults. This device also stores the data counting ECG, HR, and breath rate. But it also had disadvantages that they are matured for adults, not for children and it is of quite higher cost. To overcome these disadvantages, they came out with a smarter idea of belt system which is incorporated with electrocardiograph, a piezoelectric sensor, and a microcontroller unified into a network. This system encompasses sensors for respiratory and cardiac tracking. They also made the experimental culminate by choosing children's aged between 2 and 5. Finally they came to the conclusion that heart rate fluctuation is an is a fruitful indicator of stress feedback from children.

Iftekhar Uddin Ahmed et.al., Proposed a system which is useful for the autism kids. They developed a wearable health monitoring system technology along with the GPS tracking competence. Children's suffering from autism will have several health controversies. So, it becomes important for the parents of autism affected children to audit their child regularly. The autism affected children requires perpetual monitoring of their HR, pulse, body temperature which is quite difficult for the parents and the curators. Another problem is to track the location of autism child wherever they go. For this they developed an Aurduino-based wearable device which overcomes the disadvantages of conventional tracking systems through which they can observe their movements and health accustom and this is made possible even from the remote places using a Smartphone or tab by means of wireless communication. The proposed system consists of two sole units namely the power generation unit and data processing unit. The solar panel, a DC battery, boost converter is contained in the power generation unit. Another advantage of the system is that they can be charged either manually as well as through automatic charging system. The wearable hat is adhered with the solar panel and the boost converter. The usefulness of the solar panel is that the system never gets turned off due to low power. The boost converter sustains the voltage that is nourished from the solar panel. The data processing unit is further divided into two units namely sensor unit and data transmission unit. Pulse sensor and temperature sensor is contained in the sensor unit. The data transmission unit consists of microcontroller, SD card module and GSM and GPS module. Here the sensors serve the purpose of data collection of important health

condition in some readable form and is sent to the parents or curators through the GSM module. Locating the position of children is done using the GPS technology. The GPS system also gives the exact latitude and longitude positioning of the children. The data is also being stored in the SD card. An additional spotlight called an Emergency button is also added to the device. This emergency button is specially designed for the autism kids. If they feel annoyed or if they are in need of some obligation they can tie his parents through this button. The power supply unit consists of Silicon based mini solar panel connected in series and is used to provide the decisive amount of voltage and current. This system assures the security of the autistic child [12]. This system too reduces the apprehension of the parents and curators. As this system brings about the real-time data, it will disclose the parents as soon as a crunch situation occurs.

Hend S. Al-Khalifa et.al., Says that the prerequisite skills include habits like eating, sleeping, talking, using toilets properly. These skills lack somewhat in autism kids. They proposed the stipulation quotient of Toilet Training Sequencing (TTS) wearable watch that helps the autism children in toilet training. This helps the autism affected child to adapt to any kind of environment. They use wearable watch as modern technique to replace the paper based activity [13]. The screen of the watch displays the sequence of activities with a time frame. The time frame is chosen accordingly to the participant. The TTS watch has a subtle brunt on the autistic children. They tested it in non-profit specialized centres in the country. The result revealed that the watch will have a colossal impact on the autistic children lives.

Sami S. Alwakelet et.al., Proposes machine learning based electronic system. They serve the purpose of activity recognition in autism children using wireless sensor networks (WSNs). Autistic children have anomalous habits which is perilous or even unsafe to them [14]. The developed system is named as Autistic Child Sensor and Assistant System (ACSA) which mainly comprises of three components namely: ACSA Wearable sensor device, the companion ACSA Parent Application and the machine learning algorithms. The ACSA components includes 1) GSM/SMS which is used to send text messages to parent apps or caretakers and also it serves the purpose such as receives corrective order from parent apps, 2) GPS is used in both the kind of situations, suppose the child is within the safe boundary if not it sends an alert message, 3) Temperature sensors are embedded in the device in two different ways. One is seated inside and it is close to the body skin and the second one is seated outside to measure the temperature

of the environment, 4) Heart beat sensor which recognizes any anomalous activity of the heart and if the heart beat goes out of range it immediately gives an alert, 5) Repetitive and undesired movement sensor is armed with three movement sensors, 6) Sound sensor which is used to detect any abnormal sounds or difference in breathing patterns, 7) Real Time Operating System used to manage the overall system such as the correctness of the sensor and harmony of the alarm, 8) Ambient control, this is where ACSA and parent apps interact in a physical space, 9) Intelligent Battery Control used for the purpose of recharging the wearable device. Through this device they expedite sensing of autistic child activities.

Choel-Hong Min et.al., Describes the stereotypical self-stimulatory behavioural patterns with respect to different positions of sensors. They focussed on the position of the sensors and the number of sensors are taken into account. Extrication of features is done with time-frequency methods. Usage of single sensor have accomplished 95.5% classification rate for rocking and 80.5% for flapping. Their developed system consists of two sensor organizations. The first one is based on multiple wearable sensor that is being set upped in different parts of the body [15]. Audio and Video sensors comprises of the second system. Demeanours of autistic children are detected using this system.

3. CONCLUSION

This study proposes the overall survey about Wearable technologies developed for autistic children and giving alert messages to the parents and caretakers. There are still possible approaches which enhances the technology in the forthcoming years. The disparate algorithms can also be taken into account. Yet the cause for autism is not manifested, evidence suggest that viruses, genetics, pollution have a direct effect. In future, working with machine learning improves the wearable technology and gives the results accurately.

ACKNOWLEDGEMENTS:

The authors are deeply grateful to SRIT Coimbatore for providing the necessary facilities for the preparation of the paper.

REFERENCES

- [1] Sumin Helen Koo, Kim Gaul , Susan Rivera , Tingrui Pan , Dan Fong "Wearable Technology Design for Autism Spectrum Disorders", pp.1-19

- [2] Tianyan Zhou , WeichengCai , Xiaoyan Chen , XiaobingZou , Shilei Zhang , Ming Li, “Speaker Diarization System for Autism Children’s Real-Life Audio Data “,pp.1-5.
- [3] Min-Chun Tuan, Shih-Lun Chen, Ph.D. and Ting-Lan Lin, Ph.D, Ho-Yin Lee, Ph.D “An Efficient Micro Control Unit Vlsi Design For Wearable Electronics And Sensor Networks”, pp.1-7.
- [4] FauziaFazana , AbeerAlsadoon , P.W.C. Prasad , Nectar Costadopoulos , A. Elchouemi, SasikumaranSreedharan “Integration of Assistive and Wearable Technology to Improve Communication, Social Interaction and Health Monitoring for Children with Autism Spectrum Disorder (ASD)”, pp.1-5.
- [5] Yan Shi, Saptarshi Das , Sarah Douglas, and Subir Biswas “An Experimental Wearable IoT for Data-driven Management of Autism”, 2017 9th International Conference on Communication Systems and Networks (COMSNETS),pp.1-4.
- [6] Scott.M.Robertson “Personal Assistive Device Adults with Autism Spectrum Disorders”,pp.1-2
- [7] Cheol-Hong Min, Member IEEE “Automatic Detection and Labelling of Self-Stimulatory Behavioural Patterns in Children with Autism Spectrum Disorder”,pp.1-4.
- [8] Aaron J. Masino, Daniel Forsyth, Heather Nuske, John Herrington, Jeffrey Pennington, Yelena Kushleyeva, Christopher P. Bonafide “m-Health and Autism: Recognizing Stress and Anxiety with Machine Learning and Wearable’s Data” 2019 IEEE 32nd International Symposium on Computer-Based Medical Systems (CBMS),pp.1-6.
- [9] AzadehKushki, Ajmal Khan, Jessica Brian, EvdokiaAnagnostou “A Kalman Filtering Framework for Physiological Detection of Anxiety-Related Arousal in Children with Autism Spectrum Disorder”, 10.1109/TBME.2014.2377555, IEEE Transactions on Biomedical Engineering,pp.1-11
- [10]AkshayPuli, AzadehKushki “Towards Automatic Anxiety Detection in Autism: A Real-Time Algorithm for Detecting Physiological Arousal in the Presence of Motion”,Citationinformation:DOI10.1109/TBME.2019.2919273, IEEE Transactions on Biomedical Engineering,pp.1-13.
- [11]Erika Pittella, EmanuelePiuZZi, EmanueleRizzuto, Zaccaria Del Prete, Francesca Fioriello, Andrea Maugeri, Carla Sogos,” Wearable heart rate monitoring as stress response indicator in children with neurodevelopmental disorder”, IEEE Instrumentation and Measurement Society,pp.1-5.
- [12]Iftexhar Uddin Ahmed, 2 Nazia Hassan, 1 Humayun Rashid “ Solar Powered Smart Wearable Health Monitoring and Tracking Device Based on GPS and GSM Technology for Children with Autism”, International Conference on Advances in Electrical Engineering 28-30 September, 2017, Dhaka, Bangladesh,pp.1-6.
- [13]Hend S. Al-Khalifa, WafaAlrajhi, Sarah Alhassan, and Mariah Almotlag “Requirement Elicitation for a Toilet Training Wearable Watch to Serve Autistic Children”, pp.1-5.
- [14]Sami S. Alwakeel ,BassemAlhalabi ,HadiAggoune, Mohammad Alwakeel “A Machine Learning Based WSN System for Autism Activity Recognition”, IEEE 14th International Conference on Machine Learning and Applications, 2015,pp.1-6.
- [15]Cheol-Hong Min, Ahmed H. Tewfik, Youngchun Kim and Rigel Menard “Optimal Sensor Location for Body Sensor Network to Detect Self-Stimulatory Behaviours of Children with Autism Spectrum Disorder”, 31st Annual International Conference of the IEEE EMBS Minneapolis, Minnesota, USA, September 2-6, 2009,pp.1-4.

Authors Biography:



Kirubha.M was born in Tamilnadu, India, on February 03, 1993. She received her B.E in Computer Science and Engineering in 2014 from Avinashilingam University – Faculty of Engineering, Coimbatore and her M.E in Computer Science and Engineering in 2016 from Sri Ramakrishna Institute of Technology, Anna University, Chennai. She has

registered her Ph.D on Big Data Management in Anna University, Chennai during 2018. Currently She is working as Assistant professor in the Department of Computer Science and Engineering at Sri Ramakrishna Institute of Technology, Coimbatore. Her main research interests are Big Data Analytics, Ontology, Data mining. She has presented many papers in National and International Conferences. She has published her work in International Journals.



Aiyaswarya.S was born in Tamilnadu, India, on February 02, 1999. She completed her higher secondary in G.R.G Matric Hr.Sec School at Coimbatore and pursuing her B-Tech Information Technology in Sri Ramakrishna Institute of Technology. Her area of interest in Big Data Analytics.



Pavithra.M was born in Tamilnadu India, on July 02, 1999. She completed her higher Secondary in Kalaimagal Kalvi Nilayam Girls Hr. Sec. School at Erode and pursuing her B-Tech Information Technology in Sri Ramakrishna Institute of Technology. Her area of interest in Big Data Analytics.



Prinitha.R was born in Tamilnadu India, on March 20, 2000. She completed her higher Secondary in Ravilla K.R.A Vidhyashram Hr. Sec School at kovilpatti and pursuing her B.E Computer Science and Engineering in Sri Ramakrishna Institute of Technology.