Chapter 3

Review of Literature

3.1 DEVELOPMENT OF ASD

The Autism is a severe developmental disorder in first starting three years of life (Geretsegger et al., 2012). Such a situation can only diagnose at a later stage. Thus, it is very late for any treatment for autistic children who are unique in nature makes predicting treatment to be difficult and also often critical (Kientz et al., 2007). The many past research reports that one with autism showed the social interaction very less and found to be having communication issues with repetitive behavior towards peers. Survey conducted in 2008 by CDC, and it says their existence rate is 1 in 68 autistic children in America (CDC, 2012). Parent report says the prevalence of diagnosed ASD in U.S. 2011-12 found to have 2% children age between at 6-17 years. In 2007, existence rate meant 1 in 50 is significantly more than the 1.16% or 1 in 86 for children with autism in that age (Blumberg et al., 2013). In India, the prevalence rate is almost 1 in 250 children with autism (Kopetz and Endowed, 2012). Epidemiological data estimates the presence of 52 million cases of autism worldwide, affecting around 1% - 2% of children across the globe (Hahler and Elsabbagh, 2015). According to a multicentric Indian community study, it is 0.8 - 1.3% in 2- to 9-year-old children compared with the western country (Deshmukh et al., 2013). Total Indian Scale for Assessment of Autism (ISAA) scores was significantly higher among children diagnosed with autistic disorder compared to four other diagnostic groups (Chakraborty et al., 2015).

The scientist has reported that the autism carried due to disorder in the brain. In a child with ASD, the cerebellum is quite large where the corpus callosum is quite small compared to normal children brain (Boger-Megiddo et al., 2006). Another study showed that autistic children have a difference in the amygdala and the hippocampus (Amaral and Corbett, 2003). Autistic children brain have thickly packed neurons, and it is usually smaller than the healthy brain and also there is decreased Purkinje cells in their cerebellum (Hyman, 2001).
The exact reason behind the development of Autism during pregnancy remains unclear, but occurrence may be due to genetic defects. The diagnosis of the disorder is very much important because early detecting will help parents or caretakers better handle their children. Using the signals like cardiac rate, conduction, muscle contractions, and blink rates can be used to predict the mental and physical health of a person. Also, it is a known fact that these physiological signals may be induced or altered in particular environments (Welch, 2012). The ANS response like heart rate and skin temperature monitored, and significant change was observed in typically developing children and ASD children (Kushki et al., 2013). The stress detection system based on physiological signals like heart rate (HR) and galvanic skin response (GSR) using fuzzy expert systems was used to determine the individual stress level. Stress detection system provides fast decision and individual state of mind and act as a suitable application for measuring the stress level (de Santos Sierra, 2011).

It's noted that the physiological signals of autism individuals and controller children are almost same in conditions, where the social stimulus not introduced, e. g., in a closed room or at times when no one is trying to talk to him/her. However, in an environment with social context, these children may show many variations that will be useful as an indicator of autism spectrum disorder. Monitoring physiological signals are helpful to analyse the emotional state, but it may not be deceptive. ASD children frequently respond to very superficially inhabits, the contrast in developing the typical children, design, and evaluation of the physiological signals of the autistic children very much required for understanding their status.

The arterial and venous blood level difference measured by a noninvasive technique called photoplethysmography usually measures the site where blood vessels closely placed to the skin (Chan et al., 2006). The physiological signal checked for children based on the level that the pediatrician has guided the parents or caretakers for further investigation. The extracted features pulse amplitude of systolic and diastolic values are in the waveform. The postural change is measured by the difference between systolic and diastolic values of normalized low-frequency components (Bernardi et al., 1996). The benefits of PPG is that they are easy to operate, simple to use and also cost
very low. The PPG can take a measure without having direct contact with the skin surface.

The wavelet transform technique is ideally suited to study a particular event or short-duration change in signal (Cvetkovic et al., 2008). The application is that not only can manipulate and compute but also can compress the parameter called as features. Acquired biomedical signals are time variant, considering the many data points; signal will be compressed using wavelet transform to get useful parameters.

3.2 AUTISM SIGN AND SYMPTOMS IN CHILDHOOD

The autism in infancy can take full advantage of developing the young brain, even though ASD is difficult to identify in first 24 months. The symptoms observed between 12 to 18 months. The early detection helps in rewiring the brain and rectifying the symptoms. The very first stage of symptoms are absent in normal behaviour, but there is the presence of unusual behaviour. However the early detection can help them to provide better treatment, some children behave extremely different like not even responding to their mother when picked up or when they fed.

3.2.1 AUTISM SYMPTOMS

- No eye contact with peers
- No response when smiled at them
- Not responding to their name sometime
- Do not make sounds get peers attention
- Not following the objects visually like others.
- Doesn’t initiate or respond to hugging.
- Do not imitate others activities and expressions
- Do not enjoy the play during time with peers
- The difficulty is asking help or make other basic requests with peers.
3.3 GENETICS OF AUTISM

Genetics plays a significant cause of autism and the various research studies exposed in an identical twin when one has autism the following co-twin has autism too. While comparing in a fraternal twin, where if one has autism, the co-twin is rarely affected. The research is done to identify particular genes with autism have still no conclusion. Recently autism-associated genes are to be 20 or more genes. Fragile X or Rett’s syndrome are some disorders contrast to autism, where single gene identified.

Autistic individuals have compromised immune systems. This fact sometimes describes autism is an autoimmune system disorder. The working hypothesis states that the autistic child’s immune system have compromised either genetically or environmentally (e.g., chemical exposure) predisposes child will have autism. Also, the additional environmental exposure or the exposure to mercury-containing vaccine preservatives (i.e., thimerosal) lead to autism. It is supposed to be that when the parents have autistic children, their future children will also have autistic children. The cognitive disabilities remain undetected in siblings of autistic children. Hence, siblings should be assessed for dyslexia for possible developmental delays and learning disabilities.

3.4 POTENTIAL ENVIRONMENTAL CAUSES

Environmental factors are involved in autism even though genetics plays a significant role. There are no details on which environmental factors affect autism at this point. The word “autism” comes to play when people possess a particular set of symptoms; there are certain factors could cause those symptoms. Some of them are the mistrusted environmental causes, the restricted scientific evidence in vaccinations.

3.5 ASSOCIATED CLINICAL CONDITIONS

3.5.1 MENTAL RETARDATION

The estimation says that about around 75% of the ASD children have mental retardation too, but the research studies often use some of the verbal tests like verbal and
non-verbal communication towards children and its help in finding their intelligence level. In turn, the parent should also request no verbal intelligence test level followed by Test of Nonverbal Intelligence (TONI) by this technique the autistic child become more mature as the grow with proper treatment and education that helps to begin in a relationship their potential.

3.5.2 SEIZURES

It's estimated that about 25% of the autistic children have a seizure and may be developed in the early stage or may develops when he/she undergo the period of adolescence. The range of the seizure varies from normal to severe. The subclinical seizure not easily identified, and it affects the mental function of the autistic child. To determine the abnormality in the child, the short duration monitoring is not helpful and hence the continuous monitoring of the EEG signal is required for before treatment. In most of the cases, the drugs were used for decreasing the seizure activity, and also requires the continuous treatment. It's considered that vitamin-like B6 and dimethylglycine are better drugs provided towards the ASD individuals.

3.5.3 CHRONIC CONSTIPATION AND/OR DIARRHOEA

In the case of the autistic child, there is the about 50% of chronic constipation and diarrhoea. During diarrhoea, the liquid is leaked, and stool mass from intestine follows it were the manual probing often fails to find it out. The endoscopy is one of the ways to solve this problem and also the paediatric consultation is a must.

3.5.4 SLEEP PROBLEMS

The sleeping problem if one of the joint feature in the autistic children also the night walking induced in them because of the stomach acid. Hence, these problems are rectified by placing the brick under their bed so that the fall asleep. Some of the dynamic exercises may also help them to get rid of their sleep, and also some other sleeping aids can be used to the weighted blanket and mummy type sleeping bag.
3.5.5 PICA

It found that 30% of ASD children had severe PICA which includes the habit of eating the non-food items like paint diet, paper, sand and so on. Some times it can lead to metal poisoning to the child.

3.5.6 LOW MUSCLE TONE

The 30% of the autistic child is having the loss of the muscle tone that may be from moderate to severe. The child with autism tend to low potassium levels; this might solve by eating more fruits regularly.

3.5.7 SENSORY SENSITIVITIES

The children with autism are more sensitive to the sound, taste, sight, touch and so on. The high pitch sounds like alarms, and school bells can hurt them. Some children may also have the visual sensitivity, and may range from the severe sending to other sensitivity. Where the sensory sensitivity is more inconstant and varies from mild to severe. The sensitivity varies from one child to another child. The most likely many of the autistic children are facing problems with processing in both auditory and visual system. The pure tone hearing test may be used to check their hearing capability and also will help tin finding, may lead them to have pain. The autistic children will have highly insensitive to pain whereas others have very low pain thresholds. The interventions are designed to help normalize their sensory activities, like sensory integration and Auditory Integration Training (AIT), and Irlen lenses.

3.6 DIAGNOSIS AND TREATMENT REGIME

Autism disorder first described in the United States by Leo Kanner in 1943, and they designate only the most severe case. However, today autism is a spectrum that includes a profound mental retardation, no speech or communication, to more verbal, functionally physically challenged children, many of them educated in mainstream environments. The advantages of early diagnosis of autism used to improve the children
brain function, and that comprise the education planning as well as various treatments at the beginning of the stage. It will add family to support in education and reduced stress and anguish within the family members to deliver appropriate medical care to the autistic children (Cox et al., 1999). For children with autism the screening tools importantly play the role of early diagnosis of autism and identify the risk of autism level (low, medium and severe). If the parent finds that their child has autism, the parent should learn about autism and able to make informed decisions for their child. Parents understand what affect his child, they have better treating and preventing situations that cause difficulties.

The current DSM-IV-TR required benchmarks for autistic children in the following categories: The interaction like social, repetitive, restrictive, communication and stereotyped patterns (APA, 2000). The DSM-IV recognized as one of the category in the Pervasive Developmental Disorders for an ASD child. The ASD is used to recognize officially, under which the diagnoses of autism. The category of ASD will officially recognize have been used before to detention autism, Asperger Syndrome, and PDD-NOS and the range of impairments these diagnoses denote (APA, 2003). While changing the diagnostic method, there may be an occurrence with controversies in terms. Asperger syndrome has improved diagnosis (APA, 2000).

3.7 THE PREVALENCE OF AUTISM

- Almost 1 in 68 children had identified as autistic children in U.S.(CDC, 2014)
- ASDs occurrence rate more prevalent in boys compares to girls
- It is reported to take place in all cultural, racial, and socio-economic groups.
- The studies say average rate of prevalence about 1% in Asia, Europe, and North America
- 1 in 42 boys and 1 in 189 girls identified with ASD in U.S.(CDC, 2014)
- 1 in 250 children with autism in India
- The rate of prevalence reported 2.6 % in South Korea
- Almost 1 in 6 children had a developmental disability in U.S. reported in 2006-2008
3.8 TOOLS FOR DIAGNOSING THE AUTISM

The evaluation for the diagnosis of autism should be including the processes of the parental report, child surveillance, communications, cognitive, behavior and clinical finding results. For self-assessment, Gilliam Autism Rating Scale was used to identify and estimate the severity of symptoms with age group between 3-22 years (Gilliam, 1995). The Parent Interview for Autism was used to gather diagnostically relevant information from parents (Stone and Hogan, 1993). The Childhood Autism Rating Scale was designed to identify the autism and developmental delays or mental retardation for young children (Schopler et al., 1980). They measure to use the overall calculation as well as the possibility of involvement, imitation, interaction with peers, creative, Language, and nonverbal communication. Autism Diagnostic Interview-Revised (ADI-R) scale was used to predict various scales like social awareness, communication, and sacred behaviours (Lord et al., 1989; Lord et al., 1994; Lord et al., 1997). It permits DSM-IV (APA, 1994) and ICD-10 (WHO 1992 and WHO 1993) diagnosed within the autistic spectrum, with actual threshold scores for the diagnosis of Autistic Disorder. The three stages of allotted parent questionnaire used in the Pervasive Developmental Disorders Screening Test- Stage 2 Siegel (1998). STAGE 1 was used to screen earlier level of autism and Stage 2 to screen the Developmental Disorders Clinics, and Stage 3 for Autism or PDD Clinics.

The autism screening tool was theoretical derived and interactive measure that can use to discriminate the autism from other developmental disorders. In this experiment, 20 minutes play the respective section with autism children which involving 12 activities. Screening tools have three major sections developmental cycle like during play, motor imitation, and nonverbal communication (Stone, 1998a; Stone, 1998b). The Autism Diagnostic Observation Schedule- Generic (ADOS-G) is an observational calculation that has four criteria. Its includes activities involved directly with the investigators to calculate related reciprocal social interaction, communication as well as behavior patterns (DiLavore et al., 1995; Lord et al., 1989; Lord et al., 2000).
3.9 TECHNOLOGIES USED FOR QUANTIFYING THE AUTISM

There are several technologies made available for quantifying the autism. However, still most challenging will be the application areas of technology in autism was in healing situations, pervasive developmental disorders, and ASD for diagnosis, study, and treatment of disease. The technology for treatment and diagnosis of autism classified into four categories such as ‘Low’, ‘Mid’, ‘High’ and ‘Other’ technology.

3.9.1 LOW TECHNOLOGY

ASD Children will process the visual information very easy compared to the auditory information data (Pierce and Schreibman, 1994). Visual supports like clue cards joining the events in sequence, increasing the ability to understand the surroundings. Activity scheduling was essential for the autistic children, and clue card can be used to engage the autistic child in the certain independent activity, an example such as photographs, to communicate a message (McClannahan and Krantz, 1999). The Picture Exchange Communication System (PECS) inspires the autistic child to start the communicative interchange (Bondy and Frost 2001).

3.9.2 MID TECHNOLOGY

Autism children communication was developed using voice output communication aids (VOCAs) system. VOCAs are an augmentative and alternative communication system that is a self-contained, inexpensive electronic device (Beukelman and Mirenda, 1992). This method encourages to do the movements, words and dialogues used as a medium for the affected autistic child, and the primary advantage of their skills to enable the natural social interactions with others because of the generated speech output by a child (Schepis, 1998).

Romski & Sevcik (1992, 1996) studied the vital element in assisting language based development in autistic children through a process System for Augmented Language (SAL) constitute in VOCALS. In this adopted method, the communication
associates of autistic children were trained with the symbols for all the activities and their speech during the naturally happening interaction with others.

3.9.3 HIGH TECHNOLOGY

Teaching autism children through the computer-assisted methodology will increase focus in attention span, in-seat behavior, fine motor skills, and generalization skills (Jordan and Powell, 1995). Most of the previous studies have proved that computer technology is used in adopting the teaching process as well as therapy based program and well accepted by the autistic children (Moore et al., 2000). Mind reading helps autistic children to study the emotions and their expression, it provides an interactive guide to check the child’s progress (Baron-Cohen and Tead, 2003). A powerful, cartoon-like robot with a basic behavior repertoire can successfully engage children with developmental disorders. Similarly, the social robots recognize and respond to human social cues with appropriate behaviors (Kozima et al., 2005).

3.9.4 OTHER TECHNOLOGY

The goal of occupational therapy for autism children is to increase their life cycle quality in home and school. The baseline and intervention phases compared for autism children, four have proved that less in non-engaged behavior, followed by three demonstrated increased frequency of goal-directed play. The improvements in the frequency of interaction were minimal. Occupational therapy for autism children includes doing the daily living activity skills like dressing, brushing teeth, and other grooming skills. For holding the some objects while handwriting or cutting with scissors autism children need fine motor skills. Gross motor skills are useful for autistic children to do their activities like walking, climbing stairs, bike ride, posture, sitting position, or perceptual skills, finding the difference and identifying activities like between colors, shapes, and sizes (Case-Smith and O’Brien, 2013).

Autism children always will have issues with language and nonverbal communication. The techniques like speech therapy might include electronic "talkers", signing or typing and improving the articulation of expression by exercising lips or facial
muscles (Schreibman and Stahmer, 2014). In autism children yoga therapy will help them to balance (their mind), healthy, socially integrated, and independent lives. Also, it will improve the focused attention of a child, as well as processing of sensory information data, communicating with others, self-regulation, and motor control activities (Ehleringer, 2010).

Music therapy is an effective method for nonverbal communication in ASD. Music used as a therapeutic tool for the autistic children for improving the restoration, psychological, mental and physical health, and also for the maintenance of behavioral, developmental, physical and social skills (Boxill and Chase, 2007). For autistic children, horseback riding therapy was used to improve level posture activities, balance, and mobility of their own. Its develops a real connection between the horse and autistic children (All et al., 1999). The autism child exposed to therapy like horseback riding is much useful and improves the excellent level of sensory related problems and solution to social issues (Bass et al., 2009). Macauley and Guiterrez (2004) proposed the investigation based on the animal-assisted therapy assessment with the traditional.

3.10 INTERVENTION

To increase in field knowledge of the autism as early intervention in autism disorder, the following methods might be used:

- Each and every caretaker of the autistic child should be depending on the internet resource.
- The caretakers should have the scientific knowledge to make decision-making.
- The national autism center should take most effective measures in promoting the evidence-based practice in the field of autism.
- There should be evidence-based intervention and should follow the steps like
  - Identification
  - Implementation
3.11 WHAT IS NOT KNOWN?

An active researcher should have knowledge of what is not known and what has to diagnose in autism and what all parameters to be considered.

- The researcher based treatment allows one to find out the critical issues in the autistic children.
- One should give priority to providing measurement to the child depending upon the benefits.
- The followed medication should have higher treatment gain.
- At the chronological ages, there is the possibility for the degree of cognitive impairment, the problem in the level of language and behavioural impacts.
- The treatment method should be likely to implement and easy to leads, and it should also be very much pleasant to use.
- According to the child with ASD interaction to the peers is one of the challenging factor and hence the individual care and improvement must be given in this area.

3.12 PHYSIOLOGICAL SIGNALS

Welch (2012) stated that biosignals provide vital information about the effectiveness and will give the feedback related to the autistic children about the stimuli like social and emotional clues. Physiological signals are the reliable source of indication for the emotion of autistic children. The pulse signal is collected using the pulse oximeter from the finger tip. The pulse oximeter monitors the variations in light absorption in the skin, and the signals extracted. When placing the sensor depending on the activity while a person will be engaging with their tolerance level. Autistic children frequently respond with outwardly in ways unlike other typical children, need to have the tailored measurement and interpretation of signals need for autistic children. Sometimes the
reaction of autistic children will not be same like other typical children. For example, a number of children with autism compared to number children without autism were balanced with the age difference and found to be a similar skin response. When the perform the IQ test, and verbal IQ showed the skin response were dissimilar with pairs of age, sex and IQ-matched for with and without of autism.

The challenge in understanding emotional state wires are a problem when a study conducted outside laboratory or with free activity. The device will advertise as wireless but still the sensor part to a battery and data transmitter device would suffer from the cables, which as accepted for wearable technology.

3.12.1 PRINCIPLES OF PULSE OXIMETRY

A typical Pulse Oximeter uses the principle of a pair of small LEDs operating at two different wavelengths. The red color LED with a wavelength of 660nm, the other, an infrared LED with a wavelength of 910nm. The LEDs are designed to place contrasting to the photodiode detects the light from the LEDs. Absorption on each wavelength differed significantly for the oxyhaemoglobin and deoxygenated haemoglobin (Gupta et al., 2012). The variance in the absorption of the red and infrared turn on the ratio between oxy/deoxyhaemoglobin calculated. The amount of blood in the capillaries rest on the actual blood pressure; and that varies with the heart pulsate cycle, the heart rate can also measure. The active oxygen-carrying part of the RBC is called haemoglobin, and its is an iron compound that also have four polypeptide chain. Where each link carries the molecules of oxygen.

There are two haemoglobin parts one is oxyhaemoglobin that carries oxygen, and another one is deoxyhaemoglobin that carries non-oxygen part. Hence, all haemoglobin molecules attached to the oxygen molecule (O₂), the total body of haemoglobin is said to fully saturated. Once haemoglobin unloads the oxygen molecule to tissue cells at capillary levels, then saturation gradually decreases, the normal venous saturation is about 75% and its normal saturation level is said to be between 87-97%. The two
wavelength chosen for the reason that deoxygenated haemoglobin has a higher absorption at around 660nm and 910nm oxygenated haemoglobin has the greater intake.

Oxygenated haemoglobin will allow the red light to transmit through and absorbs infrared light while the deoxygenated haemoglobin that allows infrared light to transmit through and absorbs. The finger placed between the light source and the receiver acting as a translucent site with good blood flow. If the finger detects this absorption ion blood, the ratio of absorption at changed wavelength calculated. The arterial blood absorption will occur due to the AC component and the venous, and capillary blood scattering and absorption can happen due to the tissue and bone. The DC remain constant always and rest on one another, and AC element on of the pulsatile wave that is of interest as it is the beating of the blood while each pulse seen.

3.12.2 PULSE OXIMETER CMS50E

The pulse oximeter principle is using the formula of data process based on the Lambert-Beer Law according to Hb and HbO2 spectrum absorption characteristics. Photoelectric Oxyhemoglobin Inspection Technology adopted by capacity pulse scanning and the recording technology, then two beams of the dissimilar in the wavelength of lights can be absorbed onto the human finger. The photosensitive element obtain the signal, all the information will show on the screen of the treatment device shown in Figure 3.1.

![Figure 3.1 Pulse oximeter](http://www.pulseoxstore.com/overnight-pulse-ox/cms-50e-recording-fingertip-pulse-oximeter.html)
3.12.3 TECHNICAL SPECIFICATIONS

The system performance will be displaying the SpO₂, heart rate with a bar graph, pulse wave. The device will indicate the low voltage, brightness of the screen, the resolution of the instrument SpO₂ nearly 1% and heart rate one beats per minute.

Then ‘on push’ button will have the main menu interface and clicking the power button to have the option to select "USB", and when it is needed to transmit the data to computer push the power button. Select “on” to transfer, select “off” to prevent from the transmitting the data, during the unplug the data from the computer, a dialog box will appear on the screen. The patient base information fetched SpO₂ program the users select the option to power the device on the coordinating with the display function.

3.12.4 DATA STORAGE SETTING

This instrument can record and store the measured heart rate and pulse rate and SpO₂ value and will be available on the computer. The data displays the patient reports from the setting menu, push the power button to choose the record option. Press the power button to set the start time of data storage test clicking the power button to set the time (hours and minutes), later press and hold the power button to modify the time.

3.12.5 DATA UPLOADING TO THE PC AFTER RECORDING

When the device connected to the computer by the data path which associated with the instrument. With the use of the SpO₂ Review program, the patient information and data can enter. The software will display text device connected is connected and waiting for data. To use the upload command push the power button to get the setting menu. Press the power button to select “on” button it will transfer the information to the computer. In during the storing condition, not possible to upload the stored data to the PC by the user. The uploading rules not done by artificially, during the time of the uploading of the stored data. The choice menu bar will automatically transfer control to exit. The outer probe associated with the USB outlet with the device and the associated device would turn out to be invalidation immediately. The external probe measures the data, it
will be shown on the device screen, if the remote probe removed in the instrument, and the associated probe will become active.

3.12.6 STORAGE

Compact device container is transported by good transport or according to the agreement with the carriage. The system cannot carry and mixed with toxic, unsafe, corrosive material. The storage condition of the instrument is between -20°C~55°C ambient temperature and not higher than 95% relative humidity. Once the SPO₂ software shown in Figure 3.2 installed on the computer, two icons will be displayed on the PC. One icon is for SPO₂, and the other is for SpO₂R (Review). The red heart in display says SpO₂ and green heart symbol will be shown in SpO₂ Review software. The continuous measurement in the computer selects the menu.

![Figure 3.2 SpO₂ Review](http://www.pulseoxstore.com/overnight-pulse-ox/cms-50e-recording-fingertip-pulse-oximeter.html)
Advantages

- Real-time data transmitted to computers.
- The data can be reviewed later for analysis and feature extraction.
- The device is more portable and small in size and easy for handling.
- Data uploaded to the computer by USB port.
- Automatic shutdown function: Device under the state of measuring interface.
- This instrument can store data.
- Pulse rate sound indication with alarm function.

3.13 GALVANIC SKIN RESPONSE PRINCIPLE

Psychogalvanic reflex refers to the variation in the resistance, conductance, and potential electrical properties of the skin with respect to time when subjected to various stimuli and also known as Galvanic skin response (GSR). Further, the psycho-galvanic reflex dealt mainly with the sweat glands and controlled by the sympathetic nervous system part of the ANS. The high need for constructing a psycho-galvanic reflex detector. Since when we witness a threat our body release high level of hormones that include mainly adrenaline and cortisol that raise our body for emergency action, and this symptom could lead to various diseases and to stop or detect these signs we need a Psychogalvanic reflex detector. It also helps in detection of epileptic seizures, depression, and stress level. Further, it shows a significant role in the detection of cognitive learning. The human skin conductance principle named as galvanic skin response(GSR), or Electrodermal Response (EDR) is a scheme for measuring electrical skin conductance, which varies with its moisture level. When the sweat glands in controlled by the sympathetic nervous system, thus the skin conductance is one of the indicators of psychological of physiological stimulation. There are several studies says about the dealing with functions or reactions to electrodermal activity stimuli. The skin conductance measuring device measures the electrical conductance will found between the two points and necessary to a type of ohmmeter. Then current paths in two-way along with the skin surface. The active measurement involves sending the small level of current into the human body. The emotion state of the human monitored by measuring the skin

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conductance; it is due to change in the sympathetic nervous system. The study proved that change of skin conductance is due to interpreting the fact is one of the major things in some outgoing sympathetic nervous burst. The monitoring device for skin conductance is used to read the individual health statement, need to address the human mentally state is necessary to compare to physically.

The electrodes are made up of Ag/AgCl, and since the psycho-galvanic reflex is the combination of skin conductance and skin potential. There is a need to measure both of them. Therefore, a system has to be designed with both the placement of electrodes for the measurement of skin potential. The reference electrode is used to determine skin potential with good skin contact (Katertsidis et al., 2009). Research reveals that psycho-galvanic reflex indicates the emotional state of a human being based upon the biosignals generated by the human body and emotion recognition techniques could be useful for detecting emotions based upon feature extraction method. It also states that as the person exposed to high level of stressed situation the GSR increases whereas with low-stress GSR is low. Hence, the GSR increases or decreases proportionally with the stress (Gouravajhala and Khuon, 2012). Research reveals a design of the psycho-galvanic reflex system in combination with EEG monitoring system for detection of epileptic seizures. Since the spontaneous epileptic seizures are correlated with higher galvanic skin response. The only limitation of available detecting device is that it can detect seizures at that particular time, not before their occurrences (Handri et al., 2010). Research came out with the relation between the learning and galvanic skin response. According to their research, the interactive e-learning results in low or average GSR. Since the student can learn and understand the thing whereas in the case of non-interactive e-learning the student if unable to comprehend generates much stress and hence causing increased level of GSR. It could be of great importance regarding autistic children (Westeyn et al., 2006). Action-GSR, which extracts the GSR signal from the motion artifacts regarding autistic children. Since, its wireless in nature, the arousal level of autistic children could be measured during their various movements, and their emotional, mental and physical states could easily study.
3.13.1 GALVANIC SKIN RESPONSE CIRCUIT

Galvanic skin response circuit consists of the 150 ohms resistor and a piezo touch pad are used to receive the input from the body shown in Figure 3.3. The objective is to extract major emotional observation from the acquired signals. Galvanic skin response meter used as a biofeedback system that designed to detect a human mental state. In our study, an attempt is made to develop a low-cost GSR meter using simple electronic circuitry to detect and indicate a person’s mental state or its change qualitatively.

The emotional state varies between from the person to person, and this will happen due to variation in the change in the permeability of the human skin. If the individual usually relaxed than the skin resistance is around 1-2 mega ohms, and it happens due to permeability is low on the skin. When the skin offers to increase resistance and will limit the flow of the current. However, if the person is in stress, the resistance of the skin is decreased to 25 Kilo ohms due to the outflow of water from the blood vessels and subsequent sweating. When the hand is in sweat condition, it will increase the electrical conductivity of the human skin, and the conductivity also increase. The GSR value increased when the person is stressed and reduces when relaxed the designed circuit connected to the Arduino according to the circuit the person when touching the touchpad the reading shown on Arduino serial monitor.

![Piezo touchpad with Arduino.](image)

Figure 3.3 Piezo touchpad with Arduino.
3.14 FEATURE EXTRACTION IN PPG AND GSR

Ryoo et al., (2006) proposed personalized wearable systems for the service to human based on biosignals. This system has the three wearable subsystems, the physiological sensing, human status awareness, and the service managing system. The physiological data sensing device is used to senses PPG and GSR signal from the data glove. Its transmit from the wearable system using wireless techniques. Human mind status responsiveness subsystem in the wearable device will receive the data from electrodes and will define the emotional position of a person using non-linear mapping system and rule based. For determining the status of emotion service management, subset triggers the proper function automatically. This kind of personalized service management subsystem will deliver to users based on acquired physiological signals. The various feature extraction from PPG and GSR for considering the mobility as well as the emotional status of the human mind. The human emotion change occurs related to the sympathetic nervous system and parasympathetic nervous system. Therefore, need to measure the bio-signals related to the sympathetic nervous system and parasympathetic nervous system. Moreover, the simple mobility and wearing an a suitable device like Photoplethysmograph (PPG) and the Galvanic skin response (GSR) signal will be useful for bio-signal on a simple amount measurement like sensors in contact with human fingers. The wearable device used to sense physiological signals data set, its determine state of the mind and can give the service based on brain status.

The physiological sensing system detects the signals from the sensors and transmits using the Bluetooth serial profile. The human brain state aware of the subsystem in the wearable device receives the data from biosensors to determine the status of the person. The feature extraction of R-peak detection, RR interval detection on that the interpolation is achieved then frequency domain analysis with FFT.

3.15 ASSISTIVE TECHNOLOGY

The technologies like computer-based assistive technology, (Liu et al., 2008; Bemard-Opitz et al., 2001) virtual based assistive technology, (Conn et al., 2008;
Mitchell et al., 2007), and Robot-based systems (Liu et al., 2007; Dautenhahn and Billard 2002) makes current interventions stronger to the autistic children.

3.15.1 ROBOT BASED

The recent studies explain that the engagement of the robots increases performance in the autistic children (Diehl et al., 2012). Robot-mediated intervention is used to improve the Joint Attention Skills (JA) for autistic children in a closed manner and used, which performs many different actions (Bekele et al., 2013). It can present joint attention skills through audio-visual stimuli and body gestures. What the competencies provide by the robot is depending upon the child’s interest, it can actively adapt its stimuli based on the child’s response. Autistic children gaze determined based on the head position, which determined by the LED on top of the hat. The joint attention skills inferred by the cameras mounted on the walls. The controller transmits and receives commands from both the robot and the cameras. Simultaneously, the human therapist also performed the same actions for teaching as the robot. The joint attention skills are thought to be the building blocks of the social communication skills (Poon et al., 2012; Mundy and Neal, 2000). A robot based non-verbal game ASD children with hearing disabilities. The game designed in a way that they can participate without difficulty (Akalin et al., 2013). The robot based teaching of sign language and their meaning taught to the autistic child. The method of instruction involves three level of instruction; the first level is to learn the signs and their meanings. The second tier includes the repetition of the signs twice or thrice. The final level of teaching is like the robot performs the signs, the child must write the meanings according to the signs.

De Silva et al., (2009) proposed the detection of child’s intention by eye movement through an assistive robot. The robot interact with the child to enhance the joint attention skills. The detection of the eye-gaze must train according to the complex behaviors of the autistic child. Due to this complexity, an unsupervised method of clustering is done to detect eye gaze without using the training data. This approach based on the teacher, robot and child are interaction. First the robot, however, to gain child’s interest performs dance, play music. At the same the teacher also interacts to improve
child’s attention. The robot’s hand fingers to the object, which the child must attend to the object. If the child attends, the robot presents a feedback with motion and moves to the next task. The teacher also attends to the child if the child does not perform well.

3.15.2 VIRTUAL BASED

Virtual-reality-based Social-communication Task system (VAST) addresses the different social communication skills and trying to study its physiological variation performance score. Their pre-results of this feasibility study indicates the change of the anxiety levels while interacting with VR-based social situations in an educational setting. In this research, they exposed the children to VR-based tasks, which might provoke anxiety among them, affecting their learning (Kuriakose and Lahiri, 2015). Various amounts can alter physiological signals during the virtual environments (Prendinger et al., 2005; Meehan et al., 2005) and transition state accompanied by shifts in the autonomous nervous system (Liu et al., 2009). The study relates to performance, challenge, and the ability of the student in an educational setting for autistic individuals have physiological variations in cardiac activity, the temperature of the skin, and their anxiety level (Kushki et al., 2013). The activation of the sympathetic nervous system increases the cardiac activity and the sweat gland activity during stress, which also causes a decrease in skin temperature.

Sarrafzadeh et al., (2009) proposed active assistive device promote the social interactions for children with autism. The system requires facial recognition system as hardware, software tools as training software, wearable sensors, and wireless mobile communication devices. The child wears the camera module; the input is continuously monitored and processed by the processor in the child’s pocket. The processor transmits its signal to the web, where the software tool created. Simultaneously hand gestures also monitored to improve the face detection accuracy. The facial recognition system recognized certain emotions and communicated to the child with the help of pressure gloves contacting the child’s hand. By these forces applied at each finger denotes the emotional change of the person communicating. Hence, it helps the child to focus on the person interacting with them. The tool for assisting in real situations could make the
software more efficient, the assisting device proposed by the hearing aid and a wearable pad (El Kaliouby and Robinson 2003; Robertson, 2005).

Vullamparthi et al., (2013) revealed Android application based e-learning system, which renders the Augmented reality by QR codes. The adaptable and accessible application for children with autism named as “e- Saadhya”. It helps the educators to create tasks with their smartphones, which helps the process to overcome other conventional methodologies. The QR code contributes to identifying the type of exercise from the database, download it and run it on the application. This application uses the cameras and microphones actually for displaying pictures, simultaneously narrating the meanings.

Lakshmiprabha et al., (2014) developed AR/VR system for training the autistic children. The system consists of the projector, camera, and working table arrangement. First, task the system allows to complete the keyword task by which, the child has to move the hand on the picture or object. When the child moves the hand in the query view, it acknowledges the child by giving them verbal praise or playing the desired music. If wrong, the system highlights the correct answer, by which the child have to place their hand over it. The hand movements are noted and plotted to analyze the child’s learning progress. The child has to keep over the queried picture over 1.5 seconds until the next image to avoid unwanted movements.

3.15.3 COMPUTER BASED

Sitdhisanguan et al., (2008) recommended Computer-based training (CBT) based system, the user to communicate with the computer through an input device. Here the two training process is carried on, the tangible user interface and the conventional training methods. Here both the training methods were based on shape learning. The traditional training needs a therapist where he/she must train the children to match the shape objects with the pictures. In the tangible user interface, this process is done through a screen display, where the application projects the form and the child have to match it. Shapes, plants, animals, colors and the odd man out, and from a set of patterns. The touch screen
interfaced to the microcontroller which controls the four-wire resistive touchscreen and then interfaced with PC by USB port.

The actual training implemented by the software developed by using NI Labview. The touch screen provides much ease for them in operating it, which interests them to use the training system. The RTS will have basic shapes and colors follow different levels of patterns and the levels, and then the animals, vegetables, flowers and final level trains to identify the odd man out. According to the IQ level, a particular level should be selected for the student. The student chooses the patterns set like colors or shapes from the display screen by touching it. Based on the potential drops developed at the point, the microcontroller decides if the student identifies the correct pattern. If the answer is that the microcontroller applauds like “Claps”, otherwise, an encouragement voice motivates the child to repeat it again.

The applied behavior analysis (ABA) approach is used to treat eye contact deficit (Wang et al., 2014). This ABA needs the human intervention to improve behavior with autism individuals. Due to their stressed mind, they will not attend to others, and this system proposes a wearable eye contact reminder system. This system aids the user to locate the speaker person, by collecting the audio through the microphones mounted on the eyewear. The audio processed in the laptop through Voice activity detection (VAD). The system programmed to calculate the voice angle and determines the speaker direction, and it gives an alert signal at the user interface. Hence, it helps the person to contact the person from the guidance of the sound.

Sula et al., (2013) projected a smart assistive environment for learning and improving the quality of life for the autistic children. This system can create a learning environment by using the computer, RFID reader, sensors and the good box office. The autistic children assisted through tagged cards, in activities like learning pictures, categorizing people and emotions and some math skills. This system does not substitute the face to face interaction but provides learning from a different perspective. Here the combination of IoT, P2P, web and sensor are used to monitor the autism child, sends information about them in real time to therapists. The smart environment is present in the
way to change the environment according to the child’s behavior. Hence, by assisting this way the child’s attention is at maximum.

Teoh et al., (2011) developed the real-time emotion advisor for the autistic children, which teaches them how to respond according to the other person's feeling. The system predicts the feeling of the individual and generates response according to it. The proposed system contains the emotion recognition module, which recognizes the facial expression through the camera. Then, the advisor module to respond according to the other person's feelings. The emotional consultant works based on the fuzzy logic, which uses the fuzzy If-Then rules. The emotions compared in the database according to the emotional input and derive the correct psychological advice to the person. This database upgrades in real time according to the person emotions and advises through the earphone.

Rahman et al., (2011) discussed a customized platform for autistic children taking lessons in the classroom. Each autistic child has different complexity. Hence, this software enables the teacher to customize teaching for each student. This platform made so that the schools can accept the autistic children and offer them the better learning environment. The designed system the software that encourages the alphabet-training to the autistic students. The system provides a teaching method by which every student has a computer. Every computer is connected to the server using LAN with the teacher’s computer. The monitor provides a different environment for every autistic child, according to their profile. According to the platform, the teacher gives an alphabet to the child; the child has to select a picture according to the letter. This teacher gets the feedback at the same time.

Venkatesh et al., (2013) paper presents the communication difficulty faced by the student and providing a computer-based assistive system to the learner. The content used in this system annotated by the general lessons utilized for the children in AARAMBH institutions, which are mainly for the preschool learners. The system uses the semantic e-learning system in teaching the lessons through the CBT system. Each child has their different profile according to their respective hybrid ontology. When the child logs in, the profile of the child gets analyzed on the ontology and then the curriculum taught. The
main aim is to join the gap between the autistic child and the existing teaching curriculum and the teaching content can be placed based on the ability of the child.

Smartphone-Based Autism Social Alert (SASA) system, which designed to help children (Chuah and DiBlasio, 2012). This system is embedded with sensors to record and analyze the autistic children behaviors. The sensor readings can be used to predict the environmental and infant’s behavior. The collected information can be used to train the particular classifiers according to the sensor input. The system can correlate the database readings with the behavioral readings to learn the social viewpoint of the child. The system can identify each sensor inputs separately and train it according to their stereotypical behavioral readings. It also sends the message or call the caregivers according to it.

Jain et al., (2012) proposed a design system of an interactive game for the ASD children. This game uses the computer modern vision and graphics techniques. The standard game developed uses a single loop of interaction, but here the design involves multiple loops of interaction. The game developed tracks the student facial features through the webcam. It tracks mainly the student’s facial expression and put in an avatar, which mimics the expression of the student. The system analyzes and mimics the six basic expressions on the avatar. Hence, by this, the student views his/her expression on the avatar and also performs the expressions as the avatar narrates (Ogino et al., 2008).

A system to assist the autistic children with the learning system and the vision system. The learning system learns the visual features with the higher order local correlation (HLAC), which uses to differentiate the image pre and post reward. The system also separates the image, which is processed by the vision system. The images processed with top-down and bottom-up mainly to determine the attention points of the picture. The points are selected through the saliency levels respectively. The attention points are captured by the robot while seeing the caregivers face and also the object. This process is the same for the students undergoing ABA.