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Treatment Pattern Suggestion in Autistic Children using ML

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Abstract - Children with Autism Spectrum Disorder are identified as a group of people who has difficulties in socio-emotional interaction. Most of them lack the proper context in producing social response through facial expression and speech. Since emotion is the key for effective social interaction, it is justifiably vital for them to comprehend the correct emotion expressions and recognitions. Emotion is a type of affective states and can be detected through physical reaction and physiological signals. In general, recognition of affective states from physical reaction such as facial expression and speech for autistic children is often unpredictable. Hence, an alternative method of identifying the affective states through physiological signals is proposed. Though considered non-invasive, most of the current recognition methods require sensors to be patched on to the skin body to measure the signals. This would most likely cause discomfort to the children and mask their "true" affective states. In this project we are going to judge response time of mentally retarded person from parameters like Sensory (person has given task to sense environment), Physical (system command retarded person to perform some physical activities) and Speech (person as to recognized display images). As per the response time that person's mental ability is recorded for further evaluation.

Keyword- Autism spectrum disorder, Speech recognition, Speech processing,Image processing

I. INTRODUCTION

Deficits in intellectual ability have been linked to deficits in emotion understanding and consequently social competence. Research suggests that individuals with mental retardation exhibit deficits in their ability to identify emotional states in themselves and others, relative to normal mental age matched controls and peers and display an inability to decode facial expressions of emotion. Emotional experience is elicited in part by a cognitive appraisal of a situation toward a goal. However, the ecological validity of previous studies is limited. In this study we developed new materials to investigate the emotion understanding skills of persons with mild to moderate mental retardation.

II. LITERATURE SURVEY

Children with Autism Spectrum Disorder are identified as a group of people who has difficulties in socio-emotional interaction. Most of them lack the proper context in producing social response through facial expression and speech. Since emotion is the key for effective social interaction, it is justifiably vital for them to comprehend the correct emotion expressions and recognitions.

Emotion is a type of affective states and can be detected through physical reaction and physiological signals. In general, recognition of affective states from physical reaction such as facial expression and speech for autistic children is often unpredictable.

A method of identifying the affective states through physiological signals is proposed in [1]. Though considered non-invasive, most of the current recognition methods require sensors to be patched on to the skin body to measure the signals. This would most likely cause discomfort to the children and mask their "true" affective states. The study proposed the use of thermal imaging modality as a passive medium to analyze the physiological signals associated with the affective states non obtrusively. The study hypothesized that, the impact of cutaneous temperature changes due to the pulsating blood flow in the blood vessels at the frontal face area measured from the modality could have a direct impact to the different affective states of autistic children. A structured experimental setup was designed to measure thermal imaging data generated from different affective state expressions induced using different sets of audio-video stimuli. A wavelet-based technique for pattern detection in time series was deployed to spot the changes measured from the region of interest. In the study, the affective state model for typical developing children aged

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between 5 and 9 years old was used as the baseline to evaluate the performance of the affective state classifier for autistic children. The results from the classifier showed the efficacy of the technique and accorded good performance of classification accuracy at 88% in identifying the affective states of autistic children. The results were momentous in distinguishing basic affective states and the information could provide a more effective response towards improving social-emotion interaction amongst the autistic children.

Akhtar, Z., & Guha, T [2] presented a computational study of gaze behavior in adolescents with ASD during their interaction with virtual agents (avatars) in a virtual reality based social communication platform. We study the implications on the subjects pupil response (pupil diameter changes) and looking pattern (fixation coordinates and duration) when exposed to the avatars demonstrating context-relevant emotional expressions. The data related to fixation and pupil response is collected using a commercial eye- tracker for subjects with and without ASD during their interactions with the avatars. This data is analyzed to investigate how the pupil response dynamics and fixation patterns of the ASD group differ from their typically developing peers. Results indicated communicator's facial expressions cansignificantly affect the gaze behavior of the ASD subjects. Reduced complexity in the pupil response dynamics and lower synchrony between pupil response and fixation pattern in the ASD group are also observed.

The EEG signals acquired in this research identify different emotional states such as positive-thinking or super learning and light-relaxation and are within the frequency range of 8 – 12 Hertz. 64 children participated in research, "Profile Indicator for Autistic Children Using EEG Biosignal Potential of Sensory Tasks" [3], among which 34 were children with ASD and 30 were normal children. The EEG data was recoded while all the children were provided with vestibular, visual, sound, taste and vestibular sensory stimulations. The raw EEG data was filtered with the help of independent component analysis (ICA) using wavelet transform and EEGLAB software. Later, for building the sensory profile, entropy approximation, means and standard deviations were extracted from the filtered EEG signals. Along with that, the filtered EEG data was also fed to a neural networks (NN) algorithm which was implemented in MATLAB. Results from the acquired EEG signals depicted that during the sensory stimulation phase, the responses of all autistic children were in an unstable state. These findings will equip and aid their learning strategy in the future.

Paper "A Feasibility Study of Autism Behavioral Markers in Spontaneous Facial, Visual, and Hand Movement Response Data ", [4] proposed a novel experimental protocol for non-intrusive sensing and analysis of facial expression, visual scanning, and eye-hand coordination to investigate behavioral markers for ASD. An institutional review board (IRB) approved pilot study is conducted to collect the response data from two groups of subjects (ASD and Control) while they engage in tasks of visualization, recognition, and manipulation. For the first time in the ASD literature, the facial action coding system (FACS) is used to classify spontaneous facial responses. Statistical analyses reveal significantly ($p<0.01$) higher prevalence of smile expression for the group with ASD with the eye-gaze significantly averted ($p<0.05$) from viewing the face in the visual stimuli. This uncontrolled manifestation of smile without proper visual engagement suggests impairment in reciprocal social communication, e.g., social smile. The group with ASD also reveals poor correlation in eye-gaze and hand movement data suggesting deficits in motor coordination while performing a dynamic manipulation task. The simultaneous sensing and analysis of multimodal response data may provide useful quantitative insights into ASD to facilitate early detection of symptoms for effective intervention planning.

In [5], Bhuyan, F et al aimed to bridge the gap. Authors identified predictive features pertaining to each individual child and how they interact responding to different interventions and services. Temporal data and model improvement/regression outcomes at different time stamped milestones and overlayed a model to aid parents and caregivers in coming up with pragmatic intervention plan is also studied. Author proposed a scientific workflow to automate the modeling process and rely on DATAVIEW to guarantee computational reproducibility and data fidelity.

Paper "Sensing-enhanced Therapy System for Assessing Children with Autism Spectrum Disorders: A Feasibility Study", [6] proposed a sensing system that automatically extracts and fuses sensory features such as body motion features, facial expressions, and gaze features, further assessing the children behaviours by mapping them to therapist-specified behavioural classes. Experimental results show that the developed system has a capability of interpreting characteristic data of children with ASD, thus has the potential to increase the autonomy of robots under the supervision of a therapist and enhance the quality of the digital description of children with ASD. The research outcomes pave the way to a feasible machine-assisted system for their behaviour assessment.

Udayakumar. N [7] proposed a new intervention paradigm that act as a portable system called facial expression recognition system that recognizes virtual reality (VR) based facial expressions in a synchronous manner and also to break the dependency of an autistic child by enhancing expression based accessing and controlling process in this

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modern environment.

Paper "Comparing the gaze responses of children with autism and typically developed individuals in human-robot interaction", reported different gaze responses of TD and ASD group in two conversational contexts: Speaking versus Listening. We used Variable-order Markov Model (VMM) to discover the temporal gaze directional patterns of ASD and TD groups. The results reveal that the gaze responses of the TD individuals in speaking and listening contexts can be best modeled by VMM with order zero and three, respectively. As we expected, the result show that the temporal gaze patterns of typically developed children are varying when the role in the conversational context is changed. However for the ASD individuals for both conversational contexts the VMM with order one could best fit the data. Overall, the results conclude that VMM is a powerful technique to model different gaze responses of TD and ASD individuals in speaking and listening contexts.In [9], Serhan Coşar et al presented a unified approach for abnormal behavior detection and group behavior analysis in video scenes. Existing approaches for abnormal behavior detection do either use trajectory based or pixel based methods. Unlike these approaches, we propose an integrated pipeline that incorporates the output of object trajectory analysis and pixel based analysis for abnormal behavior inference. This enables to detect abnormal behaviors related to speed and direction of object trajectories, as well as complex behaviors related to finer motion of each object. By applying our approach on three different datasets, we show that our approach is able to detect several types of abnormal group behaviors with less number of false alarms compared to existing approaches.

David Pearson and Catherine Deeprose [10] adopted an interdisciplinary approach and present a review of studies across experimental psychology and clinical psychology in order to highlight the key domains and measures most likely to be of relevance. This includes a consideration of methods for experimentally assessing the generation, maintenance, inspection and transformation of mental images; as well as subjective measures of characteristics such as image vividness and clarity. Author presented a guiding framework in which we propose that cognitive, subjective and clinical aspects of imagery should be explored in future research. The guiding framework aims to assist researchers in the selection of measures for assessing those aspects of mental imagery that are of most relevance to clinical psychology. We propose that a greater understanding of the role of mental imagery in clinical disorders will help drive forward advances in both theory and treatment.

III. PROPOSED SYSTEM

In this project we are going to judge response time of mentally retarded person from following parameters:
Physical: system commands retarded person to perform some physical activities like wave your hand, lift your left hand, and wave your hand. These commands are system generated. Camera records video, contour recognition combining with image processing tells at which time user responded. This response time is recorded for further processing. Figure 2 shows complete process, from capturing gesture/physical activity to calculating response time. Camera captures image, it is pre-processed to de noise it and background is removed. Important features are extracted and are compared with one stored in dataset. Classifier classifies whether the physical activity was correct or not, if it is correct then system calculate response time i.e. how much time autistic child took to start

performing. In this case response time is time taken by child to understand instructions.

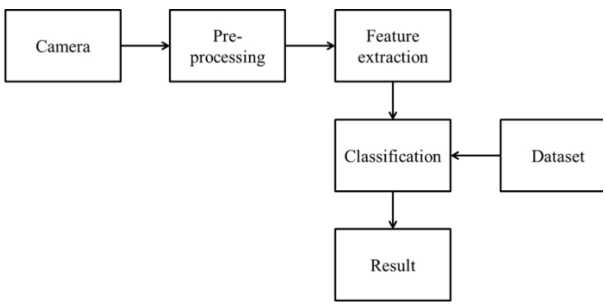

Fig 1 block diagram for sensory and physical response time analysis

Sensory: person has given task to sense environment like danger/happy moment etc. then time taken by person to sense correct environment is recorded. The system is fully automatic hence time taken is recorded by system when retarded person speaks. Speech to text module is used here. Response is recorded either as speech or action, fig 2 and fig 1 shows processing for same respectively.

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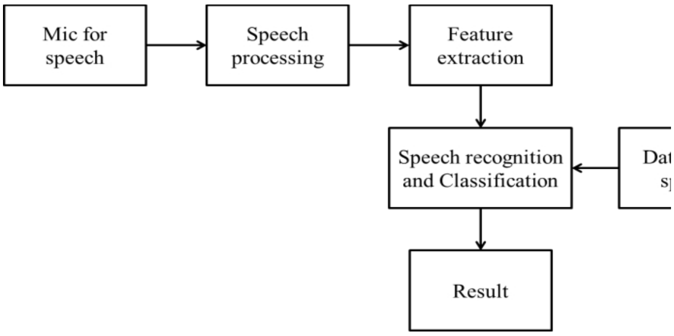

Fig 2 block diagram for speech and sensory response time

Speech: images of different objects like fruit are asked to identify image. Speech recognition is used to detect voice of user. Time elapsed from displaying image to correctly guessing images are calculated as response time. For speech processing, mic is used to acquired speech signals, this signal is then pre-processed to eliminate background noise. Important and required features are extracted and compared with dataset for recognition of speech. Speech is then classified and response time is calculated using classifier.

Algorithms Specifications: CNN

Artificial Intelligence has been witnessing a monumental growth in bridging the gap between the capabilities of humans and machines. Researchers and enthusiasts alike, work on numerous aspects of the field to make amazing things happen. One of many such areas is the domain of Computer Vision.The agenda for this field is to enable machines to view the world as humans do, perceive it in a similar manner and even use the knowledge for a multitude of tasks such as Image & Video recognition, Image Analysis & Classification, Media Recreation, Recommendation Systems, Natural Language Processing, etc. The advancements in Computer Vision with Deep Learning has been constructed and perfected with time, primarily over one particular algorithm — a **Convolutional Neural Network**.

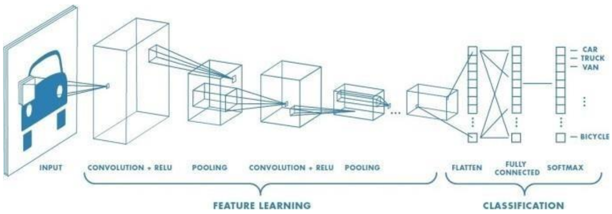

Fig. 3. architect CNN

A **Convolutional Neural Network (ConvNet/CNN)** is a Deep Learning algorithm which can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image and be able to differentiate one from the other.

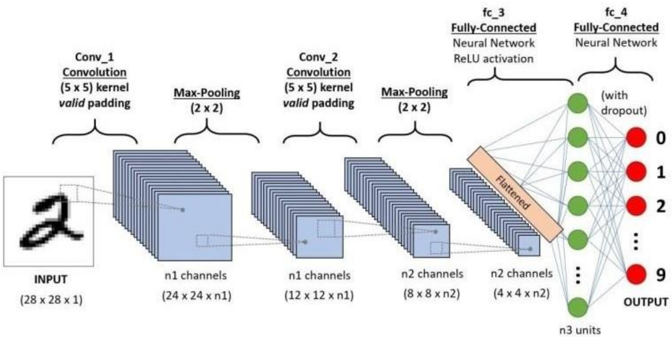

Fig.4. A CNN sequence to classify handwritten digits

The pre-processing required in a ConvNet is much lower as compared to other classification algorithms. While in primitive methods filters are hand- engineered, with enough training, ConvNets have the ability to learn these filters/characteristics. The architecture of a ConvNet is analogous to that of the connectivity pattern of Neurons in the

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Human Brain and was inspired by the organization of the Visual Cortex. Individual neurons respond to stimuli only in a restricted region of the visual field known as the Receptive Field. A collection of such fields overlap to cover the entire visual area.

IV. RESULTS

Fig. 5 Home Page

We have displayed our home page using pictures so the autistic child could gain interest while using the webpage.

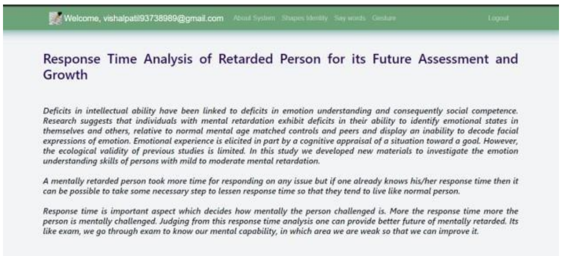

Fig. 6 about us Page

About us page describes about how the web page is beneficial for them and here we gave information about what actually an autistic child is and how could we help them to improve their response time.

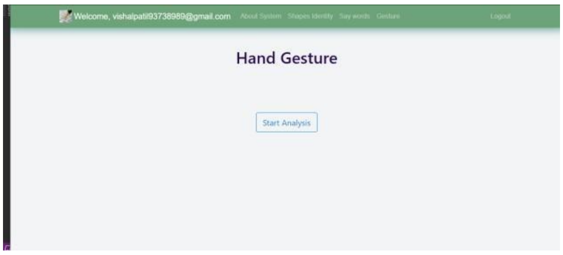

Fig. 7 Hand Gesture

The module is regarding the Hand Gestures which works by the input given and instructs the child to show his/her fingers and react to it accordingly and there we calculate the response time and the output is displayed.

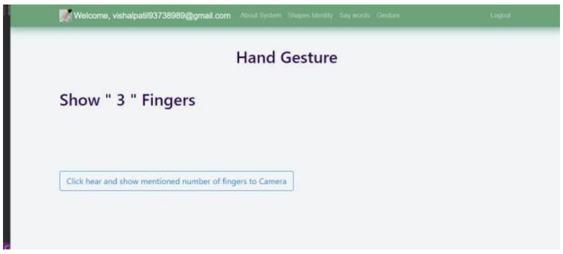

Fig. 8 Hand Gesture show 3 fingers Here the input is shown and the child has to react accordingly.

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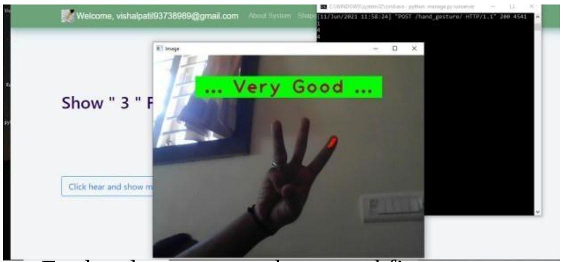

Fig. 9 Hand Gesture show 3 fingers For hand gestures we have used finger segmentation .Which gives us the real-time hand gesture recognition

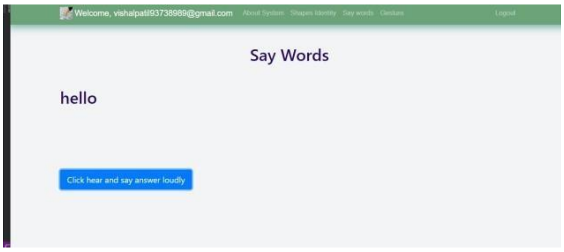

Fig. 10 Say Word

The module Say Word describes that the child has to speak the word clear and louder by which it takes the word accordingly and then the output is shown in the form of pie chart where the correct and incorrect words are calculated.

Fig. 11 Response time Word

Here the response time is calculated in form of pie chart. It has three response time and are generated according to the seconds which are Best, Good and Moderate.

Fig. 12 Shapes identity The module Shapes Identity is created such where the child has to recognize the shapes which are given as input .

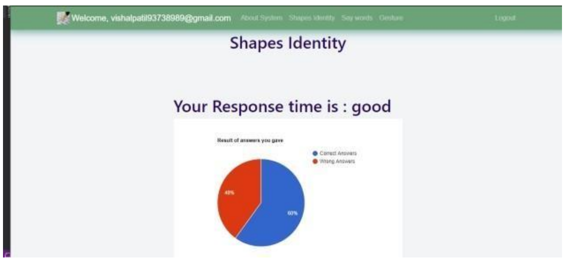

Fig. 13 Response time Shapes identity

The child has to recognize the correct shape and then the output is displayed in the form of pie chart.

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V. CONCLUSION

In this project we are going to judge response time of mentally retarded person. In this, person has given task to sense environment like danger/happy moment etc. then time taken by person to sense correct environment is recorded. The system is fully automatic hence time taken is recorded by system when retarded person speaks. Speech to text module is used here. System commands retarded person to perform some physical activities like wave your hand, lift your left hand, and wave your hand. These commands are system generated. Camera records video, contour recognition combining with image processing tells at which time user responded. This response time is recorded for further processing. Images of different objects like fruit, vegetables, stationary which user used in day to days life are display on GUI screen. User is asked to identify image. Speech recognition is used to detect voice of user. Time elapsed from displaying image to correctly guessing images are calculated as response time.

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