Emotion recognition in children with autism

A collection of papers extracted from systematic literature review under Erasmus+ EMBOA project

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#T01

Title	3D Human Sensing, Action and Emotion Recognition in Robot Assisted Therapy of Children with Autism			
Authors and full reference	Marinoiu, E; Zanfir, M; Olaru, V; Sminchisescu, C., 31st IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), JUN 18-23, 2018, p 2158 - 2167			
DOI	10.1109/CVPR.2018.00230		**Year**	2018
Children	with autism:	7	without autism:	n/a
Emotions covered	Valence, Arousal			
Recognition techniques	Kinect camera			
Value brought	Skilled therapists annotated recording from multiple therapy sessions; automatic action recognition where done considering the the RGB + depth modalities recorded using a Kinect camera.			

#T04

Title	A Computer Vision based Approach for Understanding Emotional Involvements in Children with Autism Spectrum Disorders			
Authors and full reference	Del Coco, M; Leo, M; Carcagni, P; Spagnolo, P; Mazzeo, PL; Bernava, M; Marino, F; Pioggia, G; Distante, C; 16th IEEE International Conference on Computer Vision (ICCV), OCT 22-29, 2017, p1401 - 1407			
DOI	10.1109/ICCVW.2017.166		**Year**	2017
Children	with autism:	5	without autism:	5
Emotions covered	Joy (Happiness), Fear, Sadness			
Recognition techniques	Single-camera system for facial expression analysis. Computer Vision module is made up by four main components aiming at face detection, facial landmark detection, multi-face tracking and Facial Action Unit extraction.			
Value brought	The main aim of the paper was to demonstrate if computer vision based approaches for facial feature analysis could help to understand emotional behaviors in children with the interesting perspective of introducing a computational approach for diagnosis and assessment of autism spectrum disorders.			

#T11

Title	Adaptive Framework for Emotional Engagement in Child-Robot Interactions for Autism Interventions			
Authors and full reference	Javed, H; Jeon, M; Park, CH., 2018 15TH INTERNATIONAL CONFERENCE ON UBIQUITOUS ROBOTS (UR)			
DOI	10.1109/URAI.2018.8441775		**Year**	2018
Children	with autism:	3	without autism:	3
Emotions covered	joy, anger, disgust, surprise, fear, sadness, and contempt.			
Recognition techniques	A Kinect-based motion tracking module; A facial expression recognition system that determines emotion from live video data; A vocal analysis module that detects changes in vocal cues from the child.			
Value brought	A framework was developed to determine a child's emotional state at any given point during an interaction with the goal of facilitating the delivery of robot assisted tailored therapy interventions that can evoke a higher level of engagement from children with ASD.			

#T12

Title	Affect recognition in robot assisted rehabilitation of children with autism spectrum disorder			
Authors and full reference	Liu, CC; Conn, K; Sarkar, N; Stone, W., IEEE International Conference on Robotics and Automation ICRA, 2007, p 1755 - 1760			
DOI	10.1109/ROBOT.2007.363576		**Year**	2007
Children	with autism:	3	without autism:	n/a
Emotions covered	Anxiety, Liking (enjoyment), Engagement			
Recognition techniques	- Wearable sensors for physiological signals measurement used to examine various features of cardiovascular activity, electrodermal activity and electromyogram (EMG) activity. - A Support Vector Machines (SVM) based affect recognizer module was developed.			
Value brought	'affect recognition' module is developed to elicit the affective states of liking, anxiety, and Engagement. Affective cues are inferred from psychophysiological analysis that uses subjective reports of the affective states from care givers, and a support vector machines based affect recognizer is designed that yielded reliable prediction with approximately 83% success when using the therapist's reports.			

#T17

Title	Attention Assessment: Evaluation of Facial Expressions of Children with Autism Spectrum Disorder			
Authors and full reference	Banire, Bilikis, et al. "Attention Assessment: Evaluation of Facial Expressions of Children with Autism Spectrum Disorder." International Conference on Human-Computer Interaction. Springer, Cham, 2019.			
DOI	10.1007/978-3-030-23563-5_4		**Year**	2019
Children	with autism:	4	without autism:	4
Emotions covered	No emotion recognized - facial expressions only			
Recognition techniques	Monomodal facial expression, SVM			
Value brought	Examined facial expressions during an attention tasks			

#T19

Title	Automatic Emotion Recognition in Robot-Children Interaction for ASD Treatment			
Authors and full reference	Leo, Marco, et al. "Automatic emotion recognition in robot-children interaction for ASD treatment." Proceedings of the IEEE International Conference on Computer Vision Workshops. 2015.			
DOI	10.1109/ICCVW.2015.76		**Year**	2015
Children	with autism:	3	without autism:	
Emotions covered	Joy, anger, fear, disgust, sadness, surprise and neutral			
Recognition techniques	Facial Expression			
Value brought	Focuses on facial emotion recognition. Only preliminary work done with 3 children with Asperger.			

#T24

Title	Design of Affective Robot-Assisted Activity for Children with Autism Spectrum Disorders			
Authors and full reference	Hirokawa, Masakazu, et al. "Design of affective robot-assisted activity for children with autism spectrum disorders." The 23rd IEEE International Symposium on Robot and Human Interactive Communication. IEEE, 2014.			
DOI	10.1109/ROMAN.2014.6926280		**Year**	2014
Children	with autism:	N/A	without autism:	
Emotions covered	Positive valence (smile)			
Recognition techniques	Facial EMG			
Value brought	Utilises wireless EMG to track facial expression of autistic children; not focused on emotion recognition though (only smile recognition). Reports that 70% of children agreed to wear facial EMG device.			

#T26

Title	Emotion Recognition in Children and Adolescents with Autism Spectrum Disorders			
Authors and full reference	Kuusikko, S., Haapsamo, H., Jansson-Verkasalo, E. et al. Emotion Recognition in Children and Adolescents with Autism Spectrum Disorders. J Autism Dev Disord 39, 938–945 (2009).			
DOI	10.1007/s10803-009-0700-0		**Year**	2009
Children	with autism:	57	without autism:	33
Emotions covered	Joy, anger, fear, disgust, sadness, surprise and neutral			
Recognition techniques	n.a.			
Value brought	The paper focuses on emotion recognition skills of children and adolescent with autism. However, it points out some interesting remarks: ➢ children and adolescents with ASD seem to have more difficulties than typically developing children and adolescents in recognizing emotions from the upper part of the face; ➢ the emotion recognition skills of individuals with ASD may to improve with age. Authors suggest that the intervention should start at an early stage and focus on building a positive self-esteem in individuals with ASD. The paper gives rise to the question of whether children with ASD have a tendency to interpret emotions as negative rather than positive.			

#T27

Title	Emotion Recognition in Children with Autism Spectrum Disorders: Relations to Eye Gaze and Autonomic State			
Authors and full reference	Bal, E., Harden, E., Lamb, D. et al. Emotion Recognition in Children with Autism Spectrum Disorders: Relations to Eye Gaze and Autonomic State. J Autism Dev Disord 40, 358–370 (2010).			
DOI	10.1007/s10803-009-0884-3		**Year**	2010
Children	with autism:	17	without autism:	36
Emotions covered	Joy, anger, fear, disgust, sadness and surprise			
Recognition techniques	n.a.			
Value brought	Paper describes emotion recognition by children with autism. Nonetheless, it contains important observations concerning sensors and technologies that can be used in automatic emotion recognition: ➢ children with ASD had significantly lower amplitude RSA and faster heart rate than typically developing children at baseline, suggesting lower overall vagal regulation of heart rate; ➢ a large percentage of children with autism had abnormally high sympathetic activity, i.e. skin conductance response; ➢ it is difficult to employ eye tracking technologies with lower functioning children, because the calibration and data collection processes require the child to sit still. Authors found out that making more errors in recognizing anger was unrelated to looking at particular regions of the face. They also suggest that during designing an intervention it should be taken into account that children with			

#T28

Title	Emotion recognition system for autism children using non-verbal communication			
Authors and full reference	Santhoshkumar, R. & Kalaiselvi Geetha, M. 2019, "Emotion recognition system for autism children using non-verbal communication", International Journal of Innovative Technology and Exploring Engineering, vol. 8, no. 8, pp. 159-165.			
DOI	n.a.		**Year**	2019
Children	with autism:	10	without autism:	0
Emotions covered	Joy, anger, fear, sadness and neutral			
Recognition techniques	Recordings of children with ASD body movements are used. The angle, distance, velocity and acceleration are features calculated from head, L-hand, R-hand points. The extracted features are given to the input of the Random Forest and SVM classifiers.			
Value brought	Paper proposes emotion recognition in children with autism based on features that can be calculated from recorded body movements. These features are: ➢ Distance of head, L-hand and R-hand with respect to body center ➢ Angle between the head, L-hand and R-hand with respect to body center ➢ Average velocity of head, L-hand and R-hand ➢ Acceleration of head, L-hand and R-hand with respect to body center Authors compared two classifiers, i.e. Random Forest and SVM.			

#T35

Title	Helping Neuro-typical Individuals to "Read" the Emotion of Children with Autism Spectrum Disorder: an Internet of-Things Approach			
Authors and full reference	Tang, T.Y. 2016. Helping Neuro-typical Individuals to “Read” the Emotion of Children with Autism Spectrum Disorder: an Internet-of-Things Approach. In Proceedings of the The 15th International Conference on Interaction Design and Children (IDC ’16). Association for Computing Machinery, New York, NY, USA, 666–671.			
DOI	10.1145/2930674.2936009		**Year**	2016
Children	with autism:	Not given	without autism:	Not given
Emotions covered	Happiness and sadness			
Recognition techniques	HD Face SDK in Kinect 2.0 heart rate and perspiration (in future)			
Value brought	Research presented in the paper is at very early stage. However, the paper hightlights important challanges in emotion recognition in children with autism: - integration of multiple sensor data in order to generate meaningful emotional label - how or whether Emotion API can be applied for emotion recognition in children with autism - collecting a training set of data from children with ASD The paper points out two interesting questions: 1) How will the children’s emotion be displayed? 2) Does emotional affect vary with the severity of the disorder? How can this be accounted for and by the model?			

#T41

Title	Live Monitoring System for Recognizing Varied Emotions of Autistic Children			
Authors and full reference	Fadhil T.Z., Mandeel A.R. ICOASE 2018 - International Conference on Advanced Science and Engineering, 2018, IEEE, pp.151 - 155			
DOI	10.1109/ICOASE.2018.8548931		**Year**	2018
Children	with autism:	7	without autism:	7
Emotions covered	Sadness, happiness, nervous, hunger, relaxation, trapidation			
Recognition techniques	GSR			
Value brought	Research presented in the paper is at very early stage. GSR data were compared between children with autism and typically developing ones. Lessons learned: - Pictures are not a good stimuli for evoking emotions in children with autism - Children with autism have more irregular patterns of skin conductance physiological signal			

#T42

Title	Multimodal Emotion Perception in Children with Autism Spectrum Disorder by Eye Tracking Study			
Authors and full reference	Su, Q; Chen, F; Li, HF; Yan, N; Wang, L,:Multimodal Emotion Perception in Children with Autism Spectrum Disorder by Eye Tracking Study, 2018 IEEE-EMBS CONFERENCE ON BIOMEDICAL ENGINEERING AND SCIENCES (IECBES), 382 - 387			
DOI	10.1109/IECBES.2018.8626642		**Year**	2018
Children	with autism:	10	without autism:	19
Emotions covered	valence			
Recognition techniques	eye gaze patterns			
Value brought	Reaction patterns of eye gaze was analysed as an reaction to a stimuli of videos containing human faces. Main fidings: - There are differences between ASD and TD conditions in fixation duration time regarding different areas of interest (eyes, mouth) - There are differences in reactions to positive and negative emotions presented in stimuli - Live videos of natural, real human are good stimuli for tracking reaction patterns in children with ASD - Familiarisation stage (to measurements conditions and procedures) is recommended for children on autism spectrum			

#T45

Title	Online affect detection and robot behavior adaptation for intervention of children with autism Multimodal Emotion Perception in Children with Autism Spectrum Disorder by Eye Tracking Study			
Authors and full reference	Liu, CC; Conn, K; Sarkar, N; Stone, W, Online affect detection and robot behavior adaptation for intervention of children with autism, IEEE TRANSACTIONS ON ROBOTICS, Volume 24, Issue 4, 2008, 883 – 896, 1552-3098			
DOI	10.1109/TRO.2008.2001362		**Year**	2008
Children	with autism:	6	without autism:	0
Emotions covered	Liking, anxiety, engage			
Recognition techniques	Modalities: physiological signals (cardiovascular activity, electrodermal activity, electromyogram, temperature) Techniques: SVM, ANOVA, correlations			
Value brought	This is a complex and comprehensive study of human-robot interaction loop, especially focusing on child physiological response. Main findings: - Automatic emotion recognition based on physiological signals and SVM classifier was used along with self-report and tagging by a professional - Self-report in children with autism was only partly consistent with tagging by therapists - There were differences in physiological signals between different (easy/difficult) robot behaviour patterns - Therapists's reports were taken as a „ground truth" for classification - Classification provided 82% accuracy Recommendations and challenges: - Before automatic emotion recognition is performed it's advisable to define a list of emotional states that would provide a value from the intervention perspective. - Children with autism deficits in communication skills make it hard to apply classic methods of tagging			

#T47

Title	Physiological Detection of Affective States in Children with Autism Spectrum Disorder			
Authors and full reference	Sarah Sarabadani, Larissa C. Schudlo, Ali Akbar Samadani,and Azadeh Kushski, IEEE Transactions on Journal Affective Computing			
DOI	10.1109/TAFFC.2018.2820049		**Year**	2018
Children	with autism:	15 children (3 female) with ASD between 12 and 18 ages	without autism:	0
Emotions covered	valence (positive, negative) and arousal (high, low)			
Recognition techniques	n.a.			
Value brought	- Paper investigates detection of autonomic responses to positive and negative stimuli in children with ASD using four physiological measurements (electrocardiograms, respiration, skin conductance and temperature) - Affective states are induced by stimuli of positive and negative valence or high and low arousal which are then differentiated with accuracy 80% using ensemble of classifiers. - The results of the paper suggest the feasibility of discerning affective states in individuals with ASD objectively using physiological signals.			

#T48

Title	Physiology-based affect recognition for computer-assisted intervention of children with Autism Spectrum Disorder			
Authors and full reference	Changchun Liua, Karla Conna, Nilanjan Sarkar,Wendy Stone, International Journal of Human-Computer Studies, 66, 662–677			
DOI	j.ijhsc.2008.04.003/j.ijhsc.2008.04.003		**Year**	2008
Children	with autism:	6 children in the age range of 13–16 years	without autism:	0
Emotions covered	Liking, Anxiety Engage			
Recognition techniques	Support Vector Machine (SVM)			
Value brought	- Paper addresses the problem of how to make the computer-based ASD intervention tools affect-sensitive by designing therapist-like affective models of the children with ASD based on their physiological responses. -Two computer-based cognitive tasks are designed to elicit the affective states of liking, anxiety, and engagement that are considered important in autism intervention. - A support vector machines (SVM)-based affective model yields reliable prediction with approximately 82.9% success when using the therapist's reports.			

#T49

Title	Recognition of emotions in autistic children using physiological signals			
Authors and full reference	Niranjana Krupa, Karthik Anantharam,Manoj Sanker, Sameer Datta, John Vijay Sagar, Health Technology, 6:137–147			
DOI	10.1007/s12553-016-0129-3		**Year**	2016
Children	with autism:	30	without autism:	30
Emotions covered	Neutral, Happy			
Recognition techniques	Support Vector Machine (SVM)			
Value brought	- A wearable wristband is used in the paper to acquire physiological signals (galvanic skin response (GSR) and heart rate variability (HRV). - Support vector machine (SVM) classifier is used to predict emotional states such as neutral, happy and involvement of children with autism. - Features extracted from the recorded physiological signals are classified into different emotional states using SVM, which resulted in an overall accuracy of 90%.			

#T51

Title	Robot-Enhanced CBT for dysfunctional emotions in social situations for children with ASD			
Authors and full reference	Cristina A. Pop, Bram Vanderborght, Daniel David, Journal of Evidence-Based Psychotherapies, Vol. 17, No. 2, 119-132.			
DOI	10.24193/jebp.2017.2.7		**Year**	2017
Children	with autism:	27 children with a primary diagnosis of ASD, aged 6–12 years, were randomly assigned to either robot-enhanced therapy (RET (12 children) or treatment as usual group (15 children).	without autism:	30
Emotions covered	n.a.			
Recognition techniques	n.a.			
Value brought	- Paper aims to improve the strategies used in different social situations; modify irrational beliefs (based on Albert Ellis' REBT/CBT model); teach them adaptive behaviors in social situations associated with anger and sadness and to reduce the intensity of negative emotions. -Children with ASD from robot- enhanced therapy group showed statistically significant more rational beliefs and they had a lower level of emotional responses intensity, after treatment compared with usual group. - The paper did not found any significant differences between the two groups regarding: social knowledge and adaptive behaviors.			

#T55

Title	Specific Patterns of Emotion Recognition from Faces in Children with ASD: Results of a Cross-Modal Matching Paradigm			
Authors and full reference	Ofer Golan, Ilanit Gordon, Keren Fichman, Giora Keinan, Journal of Autism and Developmental Disorders, 48:844–852			
DOI	https://doi.org/10.1007/s10803-017-3389-5		**Year**	2018
Children	with autism:	29	without autism:	34
Emotions covered	Surprise, Anger, Happiness, Sadness			
Recognition techniques	MANOVA Analysis and Regression Analysis			
Value brought	- The paper examines facial emotion recognition in intellectually disabled children with ASD and in younger typically developing controls, matched on mental age. -The paper employs three different modalities: facial, vocal and verbal. - The results of the paper confirmed overall facial emotion recognition deficits in children with ASD had the poorest performance in recognizing surprise and anger in comparison to happiness and sadness, and struggled with face–face matching, compared to voice-face and word-face combinations compared to the typically developing group. - The performance in the voice-face cross-modal recognition task was related to adaptive communication. - The findings in the paper highlight the specific face processing deficit, and the relative merit of cross-modal integration in children with ASD.			

#T56

Title	The Cambridge Mindreading Face-Voice Battery for Children (CAM-C): complex emotion recognition in children with and without autism spectrum conditions			
Authors and full reference	Ofer Golan, Yana Sinai-Gavrilov and Simon Baron-Cohen, Molecular Autism			
DOI	10.1186/s13229-015-0018-z		**Year**	2015
Children	with autism:	30 high-functioning children with ASC, aged 8 to 11	without autism:	25
Emotions covered	Unfriendly, Disappointed, Embarrassed, Jealous, Loving, Nervous, Bothered, Amused, Undecided			
Recognition techniques	MANOVA Analysis			
Value brought	- The paper found that ASC group scored significantly lower than controls on complex emotion recognition from faces and voices. - ASC had difficulty with six out of nine complex emotions. - Cambridge Mindreading Face-Voice Battery for Children or CAM-C scores were negatively correlated with parent-reported level of autism spectrum symptoms. - Children with ASC show deficits in recognition of complex emotions and mental states from both facial and vocal expressions.			

#T58

Title	Theory of mind and emotion-recognition functioning in autistic spectrum disorders and in psychiatric control and normal children			
Authors and full reference	Jan K. Buitelaar, Marleen Van Der Wees, Hanna Swaab-Barneveld and Rutger Jan Van Der Gaag, Development and Psychopathology, 11, 39–58			
DOI	10.1017/s0954579499001947		**Year**	1999
Children	with autism:	20	without autism:	60
Emotions covered	n.a			
Recognition techniques	MANOVA Analysis			
Value brought	- The hypothesis in the paper tested that weak theory of mind (ToM) and/or emotion recognition (ER) abilities are specific to subjects with autism. - Differences in ToM and ER performance were examined between autistic, pervasive developmental disorder—not otherwise specified (PDD-NOS), psychiatric control, and normal children. - Tasks are used for the matching and the context recognition of emotional expressions. - It is noticed that autistic and PDD-NOS children could not be significantly differentiated from each other or from the psychiatric controls with a diagnosis of ADHD.			

#T59

Title	Understanding Atypical Emotions Among Children with Autism			
Authors and full reference	Carolien Rieffe, Lex Stockmann, Journal of Autism and Developmental Disorders			
DOI	10.1023/A:1005540417877		**Year**	2000
Children	with autism:	23	without autism:	87
Emotions covered	Happy, Angry, Afraid			
Recognition techniques	n.a.			
Value brought	-The paper presents that children from the autistic spectrum gave few mental state explanations in typical emotions, referring to fewer than even the 6-year-old control group. - In the case of atypical emotions, the autistic group performed as well as the 10-year-old controls. - The atypical emotions demonstrate that children from the autistic spectrum indeed have the capacity to mind read however they do not always use this capacity in the same way as normally developing children. - It is argued that the mind-reading capacity of high-functioning children from the autistic spectrum might be basically intact; unused in everyday circumstances but not necessarily defective.			

#T61

Title	Understanding emotional transfer in children with autism spectrum disorders			
Authors and full reference	Sander Begeer, Mark Meerum Terwogt, Carolien Rieffe, Hedy Stegge, Tjeert Olthof, Hans M. Koot, Autism, 14(6):629-40.			
DOI	10.1177/1362361310378322		**Year**	2010
Children	with autism:	11 children with autism, 20 children with PDD-NOS	without autism:	31
Emotions covered	Positive, Negative, Neutral			
Recognition techniques	n.a.			
Value brought	-Children were asked about their emotional responses to successive, conflicting emotional situations. - Children from the typically developing group reported a stronger influence of preceding negative versus positive emotions. - Children with autism reported equal effects of preceding positive and negative emotions, and children with PDD-NOS were relatively unaffected by the preceding emotions. - The findings in the result of the paper indicate a scripted understanding of emotions in children with autism in contrast to a more personalized understanding of typically developing children.			

#T62

Title	HumanUnderstanding emotions in others: mirror neuron dysfunction in children with autism spectrum disorders			
Authors and full reference	Mirella Dapretto, Mari S Davies, Jennifer H Pfeifer, Ashley A Scott, Marian Sigman, Susan Y Bookheimer, and Marco Iacoboni, Nat Neurosci. 2006 January ; 9(1): 28–30			
DOI	doi:10.1038/nn1611		**Year**	2006
Children	with autism:	10	without autism:	10
Emotions covered	anger, fear, happiness, neutrality or sadness.			
Recognition techniques	fMRI			
Value brought	Paper contains an fMRI design to investigate neural activity during the imitation and observation of facial emotional expressions, in ten high-functioning children with ASD (9 males; 12.05 ± 2.50 years of age) and ten typically developing children (9 males; 12.38 ± 2.22 years of age)			

#T63

Title	Understanding of Emotional Experience in Autism: Insights From the Personal Accounts of High-Functioning Children With Autism			
Authors and full reference	Molly Losh, and Lisa Capps, Developmental Psychology, 2006, Vol. 42, No. 5, 809–818			
DOI	10.1037/0012-1649.42.5.809		**Year**	2006
Children	with autism:	28	without autism:	22
Emotions covered	simple emotions (happy, sad, angry, afraid, and disgusted), complex emotions (curious, disappointed, and surprised), and complex, self-conscious emotions (proud, embarrassed, guilty, and ashamed) as well as two nonemotions (tired and sick)			
Recognition techniques	n.a.			
Value brought	Paper contains: -emotional understanding in autism through a discourse analytic framework to provide a window into children's strategies for interpreting emotional versus nonemotional encounters -consider the implications for the mechanisms underlying emotional understanding in typical development. -children with autism possess less coherent representations of emotional experiences and use alternative strategies for interpreting emotionally evocative encounters.			

#T64

Title	Understanding of Simple and Complex Emotions in Non-retarded Children with Autism			
Authors and full reference	Lisa Capps, Nurit Yirmiyat and Marian Sigmant, J. Child Psychol. Psychiat. Vol. 33, No. 7, pp. 1169-1182, 1992			
DOI	n.a.		**Year**	1992
Children	with autism:	18	without autism:	14
Emotions covered	Happy, pride, embarrassment and sadness			
Recognition techniques	n.a.			
Value brought	Paper contains a study where non-retarded autistic children are compared to normal controls on measures of emotion expression and recognition. -autistic subjects recounted appropriate examples of simple and complex emotions, and accurately labeled relatively ambiguous affect expression in pictures. -Autistic children manifested some difficulty talking about socially derived emotions, pride and embarrassment			

#T65

Title	Using sensors and facial expression recognition to personalize emotion learning for autistic children			
Authors and full reference	Valerie GAY 1, Peter LEIJDEKKERS and Frederick WONG, Studies in health technology and informatics · June 2013			
DOI	10.3233/978-1-61499-268-4-71		**Year**	2013
Children	with autism:	n.a	without autism:	n.a.
Emotions covered	n.a.			
Recognition techniques	n.a.			
Value brought	This paper describes CaptureMyEmotion, an app for smartphones and tablets which uses wireless sensors to capture physiological data together with facial expression recognition to provide a personalised interface to help autistic children identify and understand their emotions -CaptureMyEmotion enables autistic children to capture photos, videos or sounds and identify the emotion they felt while taking the picture. -a self-portrait of the child is taken and the app measures the arousal and stress levels using wireless sensors.			

#T66

Title	Visual face scanning and emotion perception analysis between Autistic and Typically Developing children			
Authors and full reference	Syeda, UH; Zafar, Z; Islam, ZZ; Tazwar, SM; Rasna, MJ; Kise, K; Ahad, MAR, UBICOMP/ISWC '17 ADJUNCT, SEPTEMBER 11-15, 2017, MAUI, HAWAII, USA			
DOI	10.1145/3123024.3125618		**Year**	2017
Children	with autism:	21	without autism:	21
Emotions covered	Joy, Anger, Fear, Disgust, Sadness, Surprise			
Recognition techniques	Tobii Eyex eye tracker			
Value brought	Paper probes into the visual face scanning patterns and emotion recognition between 21 autistic and 21 control or TD (typically developing) children when displayed pictures of 6 basic emotions (happy, sad, angry, disgusted, fearful and surprised). -The results revealed that children with autism look less at the core features of the face (eyes, nose and mouth) while scanning faces and have more difficulty in perceiving the correct emotion compared to the typically developing children.			

#T68

Title	What Affective Computing Reveals about Autistic Children's Facial Expressions of Joy or Fear			
Authors and full reference	Schuller B., Commputer, June 2018			
DOI	10.1109/MC.2018.2701647		**Year**	2018
Children	with autism:	20	without autism:	19
Emotions covered	Joy, fear			
Recognition techniques	n.a.			
Value brought	Paper summarizes the findings on autistic individuals' facial expression of emotions. Three macro-areas of equal height from forehead to chin—upper, middle,and lower face are studied. Significant differences between high-functioning autism (HFA) and TD participants for disgust and sadness can be found in all three facial areas, for joy in the upper and lower face, and for surprise in the lower face—but none for anger or fear.			

#S1

Title	Processing of Facial Expressions in Autism: a Systematic Review of EEG/ERP Evidence			
Authors and full reference	Raquel Monteiro, Marco Simões, João Andrade & Miguel Castelo Branco, Rev J Autism Dev Disord (2017) 4:255–276			
DOI	10.1007/s40489-017-0112-6		**Year**	2017
Children	with autism:	0	without autism:	0
Emotions covered	n.a.			
Recognition techniques	n.a.			
Value brought	The paper presents a systematic review to examine electrophysiological differences in emotional facial expression processing in autism spectrum disorder (ASD). It reveals the group differences and emotion by group interactions in most of the studies during facial emotion-processing tasks.			

#S2

Title	Mechanisms of facial emotion recognition in autism spectrum disorders: Insights from eye tracking and electroencephalography			
Authors and full reference	Melissa H. Black,Nigel T.M. Chen,Kartik K. Iyer, Ottmar V. Lipp, Sven Bölte, Marita Falkmer, Tele Tan,Sonya Girdler, Neuroscience and Biobehavioral Reviews 80 (2017) 488–515			
DOI	10.1016/j.neubiorev.2017.06.016		**Year**	2017
Children	with autism:	n.a.	without autism:	n.a.
Emotions covered	n.a.			
Recognition techniques	n.a.			
Value brought	Paper presents a systematic review of fifty-four studies investigating the impact of ET or EEG in the facial emotion recognition (FER) in individuals with ASD. -Findings indicate divergence of visual processing pathways in individuals with ASD. -Altered function of the social brain in ASD impacts the processing of facial emotion across the developmental trajectory, resulting in observable differences in ET and EEG outcomes			

#S3

Title	Monitoring of autonomic response to sociocognitive tasks during treatment in children with Autism Spectrum Disorders by wearable technologies: A feasibility study			
Authors and full reference	Simone Di Palma, AlessandroTonacci, Antonio Narzisi, Claudio Domenici, Giovanni Pioggia, Filippo Muratori, Lucia Billeci, The MICHELANGELO study group, Computers in Biology and Medicine 85 (2017) 143–152			
DOI	10.1016/j.compbiomed.2016.04.001		**Year**	2017
Children	with autism:	5	without autism:	-
Emotions covered	n.a.			
Recognition techniques	n.a.			
Value brought	This paper summarizes a study which acquires physiological signals during therapeutic sessions supported by interactive “serious games” and to correlate the autonomic nervous system response to the engagement of the child during socio cognitive tasks for an evaluation of the treatment effect and for the personalization of the therapy. -A wearable chest belt for electrocardiographic (ECG) signal recording was used and specific algorithms for the extraction of clinically relevant features (HeartRate , Root Mean Square of the Successive Differences and Respiratory Sinus Arrhythmia) were developed			

#S8

Title	Mirroring and recognizing emotions through facial expressions for a Robokind platform			
Authors and full reference	Vinicius Corrêa Alves da Silva, Dissertation thesis, Universidade do Minho Escola de Engenharia			
DOI	10.1109/ENBENG.2017.7889480		**Year**	2016
Children	with autism:	n.a.	without autism:	n.a.
Emotions covered	n.a.			
Recognition techniques	Zeno R50 Robokind robotic platform, Support Vector Machine (SVM), Intel RealSense 3D camera			
Value brought	This dissertation presents a robotic platform which is used as a mediator in the social interaction activities with children with special needs. The main purpose of this dissertation is to develop a system capable of automatic detecting emotions through facial expressions and interfacing it with a robotic platform in order to allow social interaction with children with special needs. System has two parts: -Mirroring Emotion System (MES) synthesis human emotions through facial expressions, on-line. MES extracts the user facial Action Units (AUs), sends the data to the robot allowing on-line imitation. -Emotion Recognition System (ERS) is able to recognize human emotions through facial features in real time. ERS uses Support Vector Machine (SVM) technique for the automatic classification of the emotion expressed by the User in real time.			

#S9

Title	Understanding the nature of face processing impairment in autism: insights from behavioral and electrophysiological studies			
Authors and full reference	Dawson G, Webb SJ, McPartland J, Developmental Neuropsychology 27(3), 403–424			
DOI	10.1207/s15326942dn2703_6		**Year**	2005
Children	with autism:	0	without autism:	0
Emotions covered	n.a.			
Recognition techniques	n.a.			
Value brought	This is a review article that examine behavioural and electrophysiological studies of face processing. It discusses studies that look at the impairments in face discrimination and face recognition in individuals with autism and their atypical strategies for processing faces. It also discusses electrophysiological studies of face processing in autism that use EEC and ERP signals that are sensitive to early stage face processing and their indication regarding early perception of facial expressions of emotion.			

#S10

Title	Sensor-Based Technology for Social Information Processing in Autism: A Review			
Authors and full reference	Andrea E KowallikStefan R. Schweinberger, Sensors 2019, 19, 4787			
DOI	10.3390/s19214787		**Year**	2019
Children	with autism:	53	without autism:	0
Emotions covered	-			
Recognition techniques	-			
Value brought	This article present a systematic literature review result in 36 Original Articles on Sensor-Based Assessment of Facial Movement, Eye-gaze, Body movement, Voice , in terms of Identification of autism spectrum disorders (ASD)-related features e.g. stereotyped gesture recognition, facial expression recognition, emotion expression and emotion recognition, joint attention, social behaviour.			

#S12

Title	Personalized machine learning for robot perception of affect and engagement in autism therapy			
Authors and full reference	O. Rudovic, J. Lee, M. Dai, B. Schuller, R. W. Picard, Sci. Robot. 3, eaao6760 (2018).			
DOI	10.1126/scirobotics.aao6760		**Year**	2018
Children	with autism:	35	without autism:	0
Emotions covered	Valence, arousal, engagement			
Recognition techniques	Audio, video (facial expressions, head movements, body movements, pose, and gestures), autonomic physiology (heart rate , electrodermal activity, and body temperature); Personalized machine learning models			
Value brought	Personalized classifiers workin on multimodal data (audio, video, and autonomic physiology) of children with autism from two cultures (Asia and Europe) achieved an average agreement (intraclass correlation) of ~60% with human experts in the estimation of affect and engagement. The study also introduces interesting recommendations regarding unobtrusive sensing, perception of changes by a robot and modulation of robot's behaviour. It points out the importance of child engagement in the interaction process and provides evidence of correlation between engagement and factors of valence and arousal in children with autism.			

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