LETTER TO THE EDITOR

Dear Editor,

AUTEMOGAZE – Efficient Emotion and Gaze Change Identification System for Autism Spectrum Disorder

The development of social skills such as facial emotions and eye gaze in children are the primary contributors to participate in a social environment (Lozier et al., 2014). Clinically it has been proved that the typically developed children could start showing facial emotions from a very early age (Farah et al., 2000). In contradiction, most of the individuals with Autism Spectrum Disorder (ASD) could have emotional deficits and are also unable to show their emotions (Fridenson-Hayo et al., 2016). The typically developed individuals are also able to represent eye gaze patterns differently during valance and emotional states (Tanaka et al., 2012), whereas individuals with ASD tend to lack in eye-to-eye emotional contact (Cañigueral & Hamilton, 2019). The relevant detection of a change in facial expressions of ASD individuals could play an important role in regulating their emotional state and improving their social behaviour.

It has been observed that the facial expressions of typically developed individuals could be recognized with the clinical potential of computer-based conventional computer systems, but the accurate identification of change in facial emotion and eye gaze of individuals with ASD could be difficult to understand or detect with manual or conventional methods (Bekele et al., 2014; Lahiri et al., 2015).

We have developed a system called AUTEMOGAZE in an attempt to optimize the facial diagnosis system of ASD and to detect changes in facial emotions and eye gaze of such individuals. The design of AUTEMOGAZE is able to detect the change in facial emotions and eye gaze in individuals with ASD through deep learning (2D-CNN) model. To achieve optimum accuracy, the AUTEMOGAZE system was trained with emotional facial images and tested with video data of 10 individuals with ASD and 10 typically developed individuals, collected from online sources (Asteriadis et al., 2009; LoBue & Thrasher, 2015; Lucey et al., 2010; Lyons et al., 1998; Smith et al., 2013). The input images were pre-processed according to the requirements of the 2D-CNN model and then converted into gray-scale through the Viola-Jones algorithm (Patacchiola & Cangelosi, 2017)

for training and testing purposes. 2D-CNN algorithm was implemented for the change identification in a facial image through the AUTEMOGAZE system.

The training analysis of the AUTEMOGAZE system was conducted using combined data sets of images and videos to identify the training capability of the system. Further, trained AUTEMOGAZE was also tested and validated through real-time videos of individuals with ASD and typically developed individuals to analyze the efficiency in terms of acquired accuracy. During the training, the proposed system reflected the average accuracy of 94.9 % and 93.3 % for the identification of change in facial emotion and eye gaze respectively. During the real-time facial videos for both groups in AUTEMOGAZE, the average percentage accuracy of 94.24% for facial emotion and 93.9% for eye gaze was observed. Thus, the statistical analysis showed that the AUTEMOGAZE system was able to produce similar results for both groups. The t-test revealed no significant difference in the facial emotion change identification percentage of the typically developed group (M=94.76, SD=2.39) and the ASD group (M=94.24, SD=2.45) under conditions; $t(9)$=0.57, p=0.28. No significant difference was observed in the results of gaze change identification percentage in the case of typically developed group (M=94.01, SD= 3.35) and ASD group (M=93.9, SD= 3.24) under conditions; $t(9)$=0.064, p=0.47. The t-statistics showed that the outcome of the system was stable with insignificant differences. The significant increment in accuracy of the proposed system was found to compare with studies by Liu et al., 2016 and Smitha & Vinod, 2015, where accuracies were found to be 82.3% and 88.51% respectively, in comparison to the proposed system, where the accuracy was approximately 94%.

REFERENCES

Asteriadis S, Soufleros D, Karpouzis K, Kollias S (2009). A natural head pose and eye gaze dataset. In Proceedings of the International Workshop on Affective-Aware Virtual Agents and Social Robots. Association for Computing Machinery. New York, United States: 1-4. https://doi.org/10.1145/1655260.1655261

Bekele E, Crittendon J, Zheng Z, Swanson A, Weitlauf A, Warren Z, Sarkar N (2014). Assessing the utility of a virtual environment for enhancing facial affect recognition in adolescents with autism. Journal of Autism and Developmental Disorders; 44(7): 1641-1650. https://doi.org/10.1007/s10803-014-2035-8 PMid:24419871 PMCid:PMC4058346

Cañigueral R, Hamilton AFC (2019). The role of eye gaze during natural social interactions in typical and autistic people. Frontiers in Psychology; 10(3): 1-18. https://doi.org/10.3389/fpsyg.2019.00560 PMid:30930822 PMCid:PMC6428744

Farah MJ, Rabinowitz C, Quinn GE, Liu GT (2000). Early commitment of neural substrates for face recognition. Cognitive Neuropsychology; 17(1-3): 117-123. https://doi.org/10.1080/026432900380526 PMid:20945175

Fridenson-Hayo S, Berggren S, Lassalle A, Tal S, Pigat D, Bölte S, Baron-Cohen S, Golan O (2016). Basic and complex emotion recognition in children with autism: Cross-cultural findings. Molecular Autism; 7(1): 52. https://doi.org/10.1186/s13229-016-0113-9 PMid:28018573 PMCid:PMC5168820 Lahiri U, Bekele E, Dohrmann E, Warren Z, Sarkar N (2015). A physiologically informed virtual reality based social communication system for individuals with autism. Journal of Autism and Developmental Disorders; 45(4): 919-931 https://doi.org/10.1007/s10803-014-2240-5 PMid:25261247 PMCid:PMC4369156

Liu W, Li M, Yi L (2016). Identifying children with autism spectrum disorder based on their face processing abnormality: A machine learning framework. Autism Research; 9(8): 888-898. https://doi.org/10.1002/aur.1615 PMid:27037971

LoBue V, Thrasher C (2015). The child affective facial expression (CAFE) set: Validity and reliability from untrained adults. Frontiers in Psychology; 5(1): 1-8. https://doi.org/10.3389/fpsyg.2014.01532 PMid:25610415 PMCid:PMC4285011

Lozier LM, Vanmeter JW, Marsh AA (2014). Impairments in facial affect recognition associated with autism spectrum disorders: A meta-analysis. Development and Psychopathology; 26(4): 933-945. https://doi.org/10.1017/S0954579414000479 PMid:24915526

Lucey P, Cohn JF, Kanade T, Saragih J, Ambadar Z, Matthews I (2010). The extended cohn-kanade dataset (CK+): A complete dataset for action unit and emotion-specified expression. In Proceedings of IEEE Computer Society Conference on Computer Vision and Pattern Recognition Workshops. San Francisco, CA, USA: 94-101. https://doi.org/10.1109/CVPRW.2010.5543262

Lyons MJ, Akamatsu S, Kamachi M, Gyoba J, Budynek J (1998). The Japanese female facial expression (JAFFE) database [Online]. Zenodo.org. Available at: https://zenodo.org/record/3451524#.Xv7aYefhVPY [Accessed on 3 Jan 2018]

Patacchiola M, Cangelosi A (2017). Head pose estimation in the wild using convolutional neural networks and adaptive gradient methods. Pattern Recognition; 71: 132-143. https://doi.org/10.1016/j.patcog.2017.06.009

Smith BA, Yin Q, Feiner SK, Nayar SK (2013). Gaze locking. In Proceedings of the 26th Annual ACM Symposium on User Interface Software and Technology. Association for Computing Machinery. New York, NY, United States: 271-280. https://doi.org/10.1177/1748048513491893

Smitha KG, Vinod AP (2015). Facial emotion recognition system for autistic children: a feasible study based on FPGA implementation. Medical and Biological Engineering and Computing; 53(11): 1221-1229. https://doi.org/10.1007/s11517-015-1346-z PMid:26239162

Tanaka JW, Wolf JM, Klaiman C, Koenig K, Cockburn J, Herlihy L, Brown C, Stahl SS, South M, McPartland JC, Kaiser MD, Schultz RT (2012). The perception and identification of facial emotions in individuals with autism spectrum disorders using the Let's Face It! emotion skills battery. Journal of Child Psychology and Psychiatry; 53(12): 1259-1267. https://doi.org/10.1111/j.1469-7610.2012.02571.x PMid:22780332 PMCid:PMC3505257

Vikas Khullar[1]*, Manju Bala[1], Harjit Pal Singh[1]

1 IKG Punjab Technical University, Kapurthala and CT Institute of Engineering, Management and Technology, Jalandhar, India

*Corresponding Author : email:vikas.khullar@gmail.com