Survey

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# Emotions Recognition in people with Autism using Facial Expressions and Machine Learning Techniques: Survey

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# التعرف على المشاعر لدى الأشخاص المصابين بالتوحد باستخدام تعبيرات الوجه وتقنيات التعلم الآلي : مراجعة

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## Abstract

Recently, a lot of studies have been interested in recognizing and detection of emotions in people with autism. The main goal of this paper is to survey different studies which have been concerned emotional state of people with autism. The survey includes two parts, first one focused on studies which use facial expressions to recognize and detect emotions. As facial expressions are considered the affective and important techniques which is used to express different patterns of emotions. Second parts of this study, focuses on different technical methods like machine learning, deep learning and other algorithms that are employed to analyze and determine the facial behaviors of people with autism. To find the optimal solution, a comparison of current emotion-detecting systems is investigated in this paper.

Keywords: Autism Spectrum Disorder, Facial expression, Emotions recognition, and affective state.

## الخلاصة

في الآونة الأخيرة ، اهتمت الكثير من الدراسات بالتعرف على المشاعر واكتشافها لدى الأشخاص المصابين بالتوحد. الهدف الرئيسي من هذه الورقة هو مسح الدراسات المختلفة التي تتعلق بالحالة العاطفية للأشخاص المصابين بالتوحد. يتضمن الاستطلاع جزأين ، يركز الجزء الأول على الدراسات التي استخدمت تعابير الوجه للتعرف على المشاعر واكتشافها. حيث تعتبر تعبيرات الوجه من التقنيات العاطفية المهمة التي تستخدم للتعبير عن أنماط مختلفة من المشاعر. ركزت الأجزاء الثانية من هذه الدراسة على الأساليب التقنية المختلفة مثل التعلم الآلي والتعلم العميق والخوارزميات الأخرى التي تستخدم لتحليل وتحديد سلوكيات الوجه للأشخاص المصابين بالتوحد. للعثور على الحل الأمثل ، يتم من خلال التحقيق في مقارنة أنظمة الكشف عن المشاعر الحالية في هذه الورقة.

**الكلمات المفتاحية:** اضطراب طيف التوحد ، تعبيرات الوجه ، التعرف على المشاعر ، الحالة العاطفية.



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## 1. Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by challenges in social interaction, communication, and repetitive behaviors[1][2][3]. ASD affects individuals differently, with a wide range of symptoms and varying degrees of severity. Common signs include difficulties in understanding social cues, repetitive movements or speech patterns, intense interests in specific topics[4][5]. People with ASD often experience difficulty in identifying and expressing their emotions, which can lead to social isolation and difficulty in building relationships[6][7]. One way to understand the emotional state of people with ASD is through their facial expressions, which can provide valuable insight into their internal emotional experiences[8]. The review aims to collate and analyze a wide range of studies that have employed various techniques to explore the emotional realm of individuals with autism through facial expressions.

Facial expressions serve as crucial indicators of emotional states, playing a fundamental role in human communication[9][10]. However, autistic individuals often exhibit atypical patterns of facial expression, making it necessary to adopt specialized methodologies to accurately identify and interpret their emotional experiences[11]. By investigating the relationship between facial expressions and emotions in autistic individuals, researchers aim to enhance our understanding of the unique emotional processing mechanisms within this population[12]. Where the Researchers have developed computer-based systems that use machine learning and deep learning algorithms to identify emotions by analyzing dynamic changes in facial expressions[13][14][15]. These systems can detect changes in the intensity, duration, and symmetry of facial musccle movements, providing an accurate assessment of an individual's emotional state[16]. By using methods based on facial expressions, researchers have found that people with ASD may have difficulty recognizing and expressing certain emotions such as happiness, surprise, and disgust[17]. They may also have difficulty regulating their emotions, leading to intense or inappropriate emotional reactions in social situations[18]. Understanding the emotional state of people with ASD is essential for developing effective interventions to improve their social and emotional function[19][20]. By utilizing methods based on facial expressions, we can gain a better understanding of the emotional experiences of people with ASD and develop strategies to help them manage their emotions effectively[21] [22].

Previous studies have employed various computational techniques to detect emotions in individuals with ASD based on facial expressions, such as machine learning, computer vision, and neural networks[15] [10] [17]. Results suggest that these techniques can identify emotional states in individuals with ASD, aid in their diagnosis and treatment[23] [24]. In conclusion, this paper will provide a comprehensive examination of the techniques employed in previous studies to explore the emotional state of autistic individuals through their facial expressions. By analyzing the strengths and limitations of these approaches, this review aims to contribute to the growing body of knowledge in the field and facilitate the development of effective interventions and support systems for individuals with autism. Understanding the intricacies of emotional expression in autism has the potential to enhance empathetic understanding and promote more meaningful interactions within this population.

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## 2. Role of Facial Expression in Autism

Face plays an important role as a communication means. Facial expressions have a great role in human contacting, as face is the most visualized part. The inner feelings of person can be read by facial expressions[9]. In machine learning field different studies have achieved about using facial expressions in communication. especially in the fields That have depended on using facial expressions like medical intervention[25], robot interaction[17], and human computer interaction[26].

Facial expressions are important for people with autism to communicate. As, face conveys important social signs and form large portion in nonverbal communications. Individuals with autism spectrum disorder may have difficulty comprehending and expressing emotions. Focusing on training autistic people to use their own facial expressions to convey their feelings may be a beneficial strategy. This may include collaborating with a therapist or other skilled expert. Or use a robot to practice expressing various emotions with different facial expressions [17].

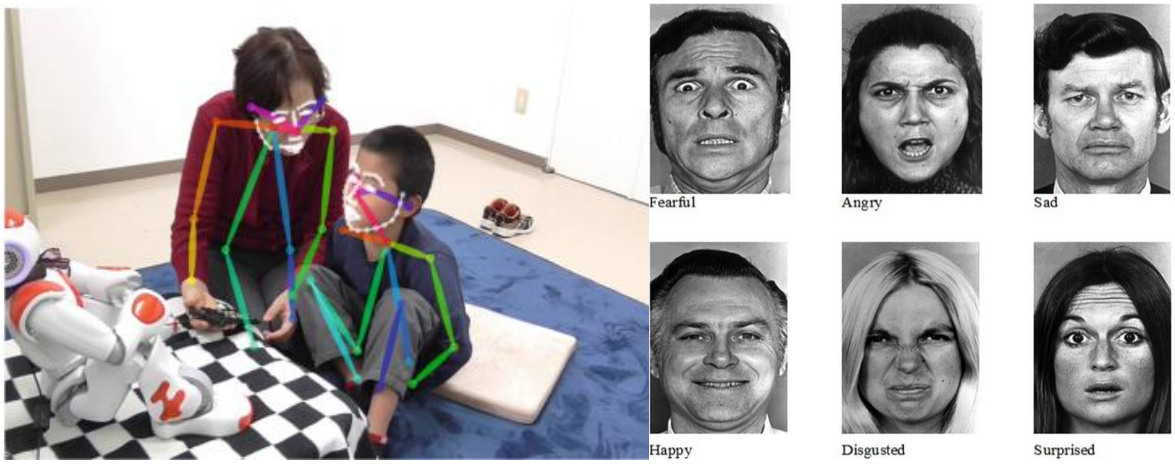


**FIG.1 (a) Expression of facial features in autistic individuals (Adapted from [MIT Lab]) , (b) Emotional identification by means of facial expression**

Overall, that the role of faces in expressing feelings for autistic patients is an important area of research, and there are a variety of strategies that can be used to help autistic. Figure 1(a) demonstrates the robot-recorded changes in an autistic child's facial expressions as a result of several circumstances. In Fig. 1(b), Many emotions are identified by facial expressions and changes in facial expressions' intensity.

This research is a literature analysis of the numerous methods for newly created technology that aims to recognize emotional states based on facial expressions. Many technologies that may identify the differences in facial appearance to comprehend the emotions and intentions of others have been suggested.

## 3. Literature Survey

- [22] , A classifier based on based on features points of facial expressions and the signals which produced from electroencephalograph (EEG) [4] was developed. The researchers used convolutional neural network (CNN) and long short-term memory (LSTM) algorithms for basic emotions classification. The participants

were 25 (35 males and 25 females). To extract the features points for face, the researchers used Haar algorithm. The maximum accuracy rate for emotion detection was 87.25%. the limitations of this work are the Lack of enough topics available to collect data and the need for more features of EEG signals

- [17], In this research, a system capable of automatically identifying emotions through facial expressions and integrating them with a robotic platform to enable social contact with youngsters with an autism spectrum disorder was developed. The experimental setup and approach for a real-time facial expression detection system relied on the Intel® RealSenseTM 3D sensor, extraction of facial features, and a multiclass Support Vector Machine classifier. Findings demonstrated that the suggested method is suitable for use in support sessions and may be utilized to promote emotion detection and imitation abilities. the limitations of this work are The poor identification rates of 'Anger' and 'Fear' in the activity IMITATE may have been owing to the fact that children had to evaluate the facial expression shown by ZECA, perhaps indicating that they did not understand the facial expression correctly.
- [20] , In their paper, Face recognition, face feature extraction, and feature classification were the three steps that went into designing the real-time emotion detection system for autistic children that was developed as part of this study. The Proposed System can only identify seven distinct facial emotions, including anger, disgust, fear, joy, sadness, contempt, and surprise. The proposed application yielded positive results when tested on an average sample of 6 to 14-year-old children. the limitations of this work are the algorithm either recognizes a face or do not, so the experiment's results cannot be statistically validated.
- [26] In their paper, they propose using Deep learning algorithms(CNN, LSTM) to identify and infer affective-cognitive states in real-time for adults with and without Asperger Syndrome (AS). The limitations of this research include the tiny sample size.
- [23] In their paper, they propose using Sensors and machine learning algorithms to develop a system for monitoring and identifying individuals with autism spectrum disorders and for emotion identification. The results demonstrate that the suggested system can identify emotion with high precision, reaching 6% higher precision than Support Vector machines and 8% greater precision than back Propagation techniques. The restrictions imposed on this work are the use of wearable devices, which are invasive devices that cause discomfort for a person
- [24] they proposed using a single-camera system for facial expression analysis and offer research on how retrieved facial data might be utilized to examine how the global and local facial dynamics of ASD vary from those of their normally developing peers. The restrictions imposed on this work are a Lack of systematic data application and incorporation of face cues such as gaze.
- [27] Researchers evaluated the posed and elicited facial expressions of people with an autism spectrum disorder. ASD emotions were seen as more intense and less normal than TD expressions, while being more precisely characterized than anticipated, with expressions of rage driving this perception. Nature ratings of elicited facial expressions were positively associated with the identification accuracy of TD people, but not ASD individuals. The restrictions on this work were that the inclusion of fixed images was a reliable experimental control, but the addition of dynamic stimuli may enhance environmental validity and convey additional social information that was absent when evaluating fixed images.
- [28] The researchers used the facial expressions analysis program to compare the ability of individuals with and without autism to repeat facial expressions through the emotion recognition paradigm, where the researchers discovered the relationship between alexithymia and the spontaneous generation of facial feelings. The restrictions imposed on this work are our sample size was modest, limited our ability to identify group differences in expression production and perhaps rendered the between-groups study inaccurate. Hence, it remains unclear if alexithymia contributes to aberrant facial expression in the ASD population.

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## 4. Face-based emotion detection methods for people with ASD

facial-based emotion detection methods are more commonly used due to their simplicity and powerful, and widely used[29]. sensitivity and Accuracy are enhanced by the non-invasive technology's capacity to distinguish facial corners, which improves the accuracy of emotion detection when identifying faces. Owing to the efficient facial recognition method, the degree of specificity is increased, but the time required to complete the operation rises. The Reliability surpasses expectations due to the likelihood of face overlap[24].

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Table 1: It will show a reasonable idea of the methods used to detect emotions through facial appearances and analyze their performance measures.

| Authors | Tools that used to capture face | Technology | Purpose | Emotions | Methodology | Accuracy (%) | Input channels |
|---|---|---|---|---|---|---|---|
| Hassouneh et al., 2020 | 1.webcam 2. EPOCþ headset | emotion recognition system | classify Autism children's emotional expressions | -happiness -sadness -anger -fear - disgust - surprise | -Cnn -lstm | 87.25% | -facial landmarks -EEG signals |
| Silva et al., 2021 | 1.computer 2.ZECA robot 3- The Intel® RealSense™ 3D sensor | 1.Emotion detection system 2.robotic platform | Develop a system capable of automatically identifying emotions via facial expressions and integrating them with a robotic platform so that children with ASD may engage in social contact. | -happiness -sadness -anger -Surprise -Fear -*neutra | Support Vector Machine classifier | 93.6% | Action unit |
| Singh and Dewan 2020 | camera | emotion recognition system | teach emotions to individuals suffering from autism | -anger -dis- gust -fear -joy -sadness -contempt -surprise | -Viola jones algorithm -adaboost | 97.85 | -AUs -head -eye |
| Sivasangari et al. 2019 | 1.wearable sensor 2. camera | emotion recognition system | surveillance and identification of individuals with autism spectrum disorders and emotion recognition | -Happiness -Sadness -Anger -Fear -Distress -Surprise | -SVM -Bayesian network | 86.83% | -facial landmarks -EEG signals |
| Dawood, Turner, and Perepa 2018) | webcam | affective model | capture students' affective-cognitive states | -confidence -uncertainty - engagement - anxiety -boredom | -Cnn -lstm | 90.06% | -facial expressions -head movement -eye gaze |
| **Del Coco et al.** | **Noninvasive technique** | **Computer vision module** | Several Action Units are identified to get desired emotion. | -Happy -Fear -Sad | **-Support Vector Machine -Conditional Local Neural Field** | - | facial expressions |
| Faso et al. 2015 | camera | **Computer vision module** | Determine whether changes in the facial affect expressivity of people with ASD diminish the accuracy and quality of an observer's judgment of their emotional state. | -Sad -Anger -Fear -Happy | -measures ANOVA | - | facial expressions |
| Trevisan et al. 2016 | camera | automated facial expression analysis software | Showing the ability of autistic patients to imitate facial expressions voluntarily | -happiness -sadness -anger -fear - disgust - surprise | Computer-assisted technologies | - | facial landmarks |

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## 5. Conclusion

Many studies have achieved in emotion recognition of people with autism. This paper have investigated the important works that have focused on recognizing emotions of people with autism based on facial expressions. Facial expressions are essential in eliciting emotions as they provide visual cues for interpreting the emotions of others. They are universal and easily recognizable, enabling communication and social interaction. Various methods have developed to capture people's emotional states, including the use of robots, education systems, sensors, invasive tools, and cameras. Performance measures of these methods depend on their accuracy, practicality, and ethical concerns.

Sensors have proven great accuracy rates in recording emotional states, the cameras can also detect tiny changes in facial expressions, voice tone, and body movements. Nevertheless, their usage creates privacy issues, since they might record data without authorization. Invasive technologies such as EEGs and fMRIs offer the potential for increased precision in recording emotional states but are not practical for daily usage, since they need specialized equipment and trained professionals. Robotics and education systems have also been designed to collect emotional states, however, their performance measurements differ depending on the specific application. Robots may offer a controlled environment to elicit emotional reactions, while education systems can give insights into the efficacy of instructional approaches. In conclusion, although each approach has its merits and drawbacks, the employment of sensors and cameras for collecting emotional states seems to be the most feasible and accurate alternative for daily usage, provided ethical considerations are addressed.

## Conflict of interests.

There are non-conflicts of interest.

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