



FACE DETECTION AND ANALYSIS SYSTEM BASED ON ARTIFICIAL INTELLIGENCE (COMPARISON OF HAAR CASCADE AND DEEP LEARNING MODELS)

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Abstract

Artificial intelligence has become one of the most important directions of scientific and technological development in recent years. With the help of these technologies, the level of efficiency and automation in various fields is significantly increasing. Face recognition and analysis systems based on artificial intelligence are widely used in modern security, medicine, mobility, and everyday life. Human face recognition is a complex problem, in which various algorithms and approaches are used. The two most common main approaches in this regard are the Haar Cascade and Deep Learning models. This article will cover the principles of operation, advantages and disadvantages of both of these approaches, as well as their role in the development of modern artificial intelligence.

Keywords: artificial intelligence, modern technologies, security, disadvantages, problem, solution, information technologies, computer software.

Facial recognition technology allows a computer program to identify a human face in an image or video stream. The main task of these systems is to extract parts of the image that contain a human face. This process consists of steps such as face detection, face segmentation, and facial feature detection. The main challenges for the technology are lighting, background, face position at different angles, facial expressions, and the presence of external objects (such as glasses or a mask). Therefore, facial recognition algorithms are required to be sufficiently robust, accurate, and fast. One of the first approaches to the problem of face recognition is the Haar Cascade algorithm, which is a very popular and widely used method. The Haar Cascade algorithm works by taking into account the Haar features that identify features of different sizes and dimensions from an image. Based on this algorithm,



it is possible to mathematically describe the location of facial features such as facial buttons, eyes, mouth and nose. The effectiveness of the Haar Cascade algorithm is manifested in its simple structure and fast learning. Also, since the algorithm is adapted to work in real time, it is widely used in many software applications. There are pre-trained versions of the Haar Cascade method, which are trained on a large set of facial and non-facial images. This method requires much less memory and computational resources. In practice, Haar Cascade face detection is very fast and can be implemented even on low-power devices. This makes it very suitable for security systems, real-time applications, and mobile devices.[1]

There are also some shortcomings. The most important of these is that the algorithm has rather poor results in detecting faces with complex backgrounds or photographed at different angles. In addition, Haar Cascade mainly detects frontal faces well, but the accuracy decreases when the face is slightly turned, the lighting changes, or facial elements are not directly visible. Also, facial features may be missed or the result may be incorrect during face recognition. In modern technologies, especially Deep Learning models based on artificial neural networks have become more widespread in face recognition. Deep Learning or deep learning technology consists of multilayer neural networks inspired by the human brain. This approach allows you to identify and analyze complex features by studying the image in depth, instead of superficial shapes and symbols.

Deep Learning models, particularly convolutional neural networks, are able to accurately distinguish faces at different angles, against complex backgrounds, and with varying lighting and facial expressions.[2]

Deep Learning-based facial recognition systems are trained on very large datasets. These datasets consist of thousands or millions of images of human faces in different compositions. During the machine learning phase, the model independently learns the specific features of the face that are detected, thereby performing the task of face recognition with extremely high accuracy. Since Deep Learning models can be constantly retrained using new examples, they can flexibly capture different facial expressions. Deep Learning-based systems require a lot of computing power. For their effective operation, powerful graphics processors and a large amount of RAM are required. At the same time, the training process can take a lot of time, but using



International Conference on Economics, Finance, Banking and Management

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24th October, 2025

a ready-made model is very fast. Another important aspect is that Deep Learning models can not only detect faces, but also automatically analyze facial expressions, gender, age, and emotions. The probability of error when recognizing faces using Deep Learning models is much lower. They are resistant to different ethnic groups, color and lighting differences, and objects placed on the face. The use of these models is widely used in security systems, mobile applications, social networks, and expanding medical capabilities. The ability to update and retrain the model makes it adaptable to modern and constantly changing needs.[2]

Facial recognition and analysis systems have opened up vast opportunities for society. Their implementation is used to solve many problems in security, identification, monitoring, marketing, healthcare, and other areas. These systems based on artificial intelligence have taken on a significant role in many aspects of human activity. In the field of digital security, facial recognition technologies play an important role not only in preventing unauthorized access, but also in ensuring the protection of personal data. They are also used to increase the level of interactivity by providing facial authentication on mobile devices, identifying users in various applications, and creating opportunities tailored to the needs of the user. In the medical field, facial analysis has made it possible to detect changes in a person's health, in particular, signs of stress, fatigue or illness, in advance. The modern development of facial recognition systems is bringing great innovations and conveniences to every area of human activity. At the same time, with the rapid development of technology and the improvement of facial recognition efficiency, issues of information security and privacy are also becoming more and more important. In this regard, it is necessary to continuously work on important aspects such as confidentiality, data protection, transparency and compliance with ethical standards when implementing technology. [3]

In the future, facial recognition systems are expected to be further improved, enriched with new functions, and the level of accuracy and efficiency is expected to increase. In this case, classical approaches such as Haar Cascade can be used in special fields due to their fast and resource-saving results, while Deep Learning models can excel in complex areas requiring high accuracy and durability. Since each approach has its own advantages and limitations, it is important to choose the



appropriate technology based on practical needs. Nowadays, facial recognition and analysis systems based on artificial intelligence are becoming an integral part of human life. With their help, user convenience, security and efficiency are being raised to a completely new level. It is natural that new opportunities arising as a result of technological progress will become a unique solution and development factor for each field. This opens a new stage for human development.[4]

Conclusion

In conclusion, artificial intelligence-based human face recognition and analysis systems play an important role in effectively solving the needs and problems of modern society. Haar Cascade algorithms are characterized by being simple, fast, and designed to work with limited resources. Deep Learning models are multifunctional, complex, sustainable, and create convenience for modern industries. Both approaches have their place in modern technological development. In the future, facial recognition technologies will continue to improve and create new opportunities for the development of society. The correct use of technology, adherence to ethical standards, and ensuring information security will remain the main principles of artificial intelligence-based systems. Based on these principles, facial recognition and analysis technologies will continue to serve to make human life easier, increase security, and create effective management systems.

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24th October, 2025

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