TASHKENT STATE UNIVERSITY OF ECONOMICS

International journal of topics

INNOVATION SCIENCE AND TECHNOLOGY

ISSUE 5

Acceptance of papers **May, 2026**

Acceptance of papers

Published monthly

Topics

economics, technology, social sciences

ISSN 3060-5229

Visit the website **t.me/jurnal_IST2100**

Electronic publication, Issue 5.
Approved for publication on May, 2026.

THE SCIENTIFIC-POPULAR ELECTRONIC JOURNAL **"INNOVATION SCIENCE AND TECHNOLOGY"** HAS BEEN REGISTERED UNDER THE NUMBER **C-5669633** BY THE AGENCY FOR INFORMATION AND MASS COMMUNICATIONS (AOKA) OF THE REPUBLIC OF UZBEKISTAN, EFFECTIVE FROM OCTOBER 9, 2024.

CONTACTS

Phone: **+998 50 737 87 88**

Website: https://ist-journal.uz

Email: innovationist2025@gmail.com

The scientific electronic journal “Innovation Science and Technology” has been included in the list of scientific publications recommended for the publication of main scientific results of dissertations for the award of PhD and DSc degrees in economics and technical sciences, in accordance with the Resolution No. 370 of the Presidium of the Higher Attestation Commission of the Republic of Uzbekistan, dated May 8, 2025.

Editorial board:

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

DEVELOPMENT OF A MODEL FOR IMPROVING FACE-ID TECHNOLOGY IN ENSURING INFORMATION SECURITY ON E-PLATFORMS

Maxamadov Rustam Xabibullayevich,
Senior lecturer, Department of Digital Technologies and Information Security, Academy of the Ministry of Internal Affairs, independent researcher
rmakademiya@gmail.com
+998935802211
ORCID: 0009-0001-5020-4592

Djamatov Mustafa Xatamovich,
Senior lecturer of the Department of Digital Technologies and Information Security, Academy of the Ministry of Internal Affairs

Abstract. *This article analyzes modern methods and algorithms for the automatic recognition of human emotions through facial expressions. The study examines the processes of facial expression identification based on the Facial Action Coding System (FACS). The possibilities of detecting emotional states, including excitement, confusion, concentration, and nervousness, through the identification of facial landmark points and the distances between them are discussed. Furthermore, the effectiveness of using the Tree-Augmented Naive Bayes (TAN) classifier and the CK+ database in facial expression analysis is investigated.*

The article also proposes a semantic model of an automated facial expression recognition system and substantiates its significance in the educational process, particularly in improving authentication and monitoring systems within electronic learning platforms. The proposed system enables continuous monitoring of students' emotional states, enhances security during examination processes, and automates personal identification procedures.

Keywords. *Facial expression recognition, emotion recognition, Facial Action Coding System (FACS), Action Units (AU), facial landmarks, biometric identification, Tree-Augmented Naive Bayes (TAN) classifier, CK+ database, artificial intelligence, computer vision, human-computer interaction, e-learning, authentication, facial movement analysis, emotional state monitoring.*

INTRODUCTION

Human beings extensively utilize emotions in the processes of information exchange and problem-solving. In the analysis of personal identification, facial recognition is considered one of the most successful methods. By taking human emotions into account during facial recognition, it becomes possible to facilitate interaction between humans and technologies through the development of user interfaces based on various models and algorithms. Numerous approaches have been employed to identify facial expressions and determine changes in human emotions under different conditions. In this article, we analyze effective facial expression recognition methods based on the localization of facial landmarks and the determination of distances between facial components. These methods enable the automatic identification of facial expressions by analyzing various facial movements and emotional states of a person from images or video camera inputs.

LITERATURE REVIEW

Various independent studies have investigated and compared person-dependent features and facial expression recognition methods [1]. The Tree-Augmented Naive Bayes (TAN) classifier, capable of distinguishing different facial characteristics, was introduced in [2]. Tree-Augmented Naive Bayes (TAN) is a machine learning algorithm that extends the traditional Naive Bayes classifier by incorporating a tree structure to model dependencies among features. While the Naive Bayes algorithm assumes conditional independence among features given the class label, many real-world scenarios involve interdependent features. TAN aims to capture

these dependencies more effectively while preserving the simplicity and computational efficiency of the Naive Bayes approach. By integrating a tree structure into the probabilistic model, TAN enables the representation of more complex relationships between variables while maintaining classification efficiency. In addition, integrated systems facilitating interaction between humans and machines have also been developed [3].

Using the SAMMI (Semantic Effect-Enhanced Multimedia Indexing) method, significant progress has been achieved in the recognition of human emotions [4]. Traditional multimedia indexing methods often rely on low-level features such as color, texture, and shape for content representation and retrieval. However, these approaches frequently fail to capture the rich semantic information embedded in multimedia data. Semantic Effect-Enhanced Multimedia Indexing has emerged as an innovative solution aimed at bridging the gap between content and context by incorporating semantic effects into the indexing process. Furthermore, the efficiency of several functions for neutral facial expressions has been compared, and three sets of features — coordinates, distances, and landmark points — have been extensively studied [5].

Researchers have established a framework for facial expression recognition using multimodal interfaces based on the CK+ database [6][9]. Adaptive learning processes and facial expressions were recorded through video sequences using the coding system developed by Ekman and Friesen [7]. One of the major limitations of conventional e-learning systems is the inability to adequately consider students' emotional states and provide personalized feedback based on integrated pedagogical models [8][10].

A brief overview of the CK+ database is also provided. In 2000, the Cohn-Kanade (CK) database was introduced to advance research in automatic facial expression recognition. Since then, the CK database has become one of the most widely used benchmark datasets for the development and evaluation of facial expression recognition algorithms.

Several internal emotion recognition applications can improve the performance of facial expression recognition systems. In such systems, certain emotions are often misclassified [6]. Although multiple approaches have been proposed for emotion recognition based on facial expressions, several challenges still exist due to variations in viewing conditions, as illustrated in Figure 1. Head position is generally categorized into three types:

pitching – facial detection when the head is tilted upward or downward;

roll – facial detection when the head is tilted sideways;

yaw – facial detection when the head is turned to the left or right side.

Developing an automated facial expression recognition system is a highly complex process. Significant progress has been achieved in extracting various facial objects and constructing their templates using facial landmark points and the distances between them.

The Facial Action Coding System (FACS) decomposes facial expressions into Action Units (AUs), which represent the smallest visually distinguishable components of facial movements. Each AU corresponds to a specific facial muscle or a group of muscles, while combinations of AUs form the basis for describing a wide range of facial expressions. This system enables a subtle and precise analysis of facial dynamics.

Researchers Paul Ekman and Wallace V. Friesen, who conducted extensive studies in facial expression analysis, emphasized the direct relationship between facial expressions and emotional states such as happiness, confusion, concentration, and nervousness. Their experiments primarily focused on emotions including excitement, confusion, concentration, and nervousness.

Excitement State:

This emotional state is observed when facial expressions exhibit a high frequency of agitation.

Indicators: smiling with an open mouth, widened eyes, and raised eyebrows.

Confusion (Hesitation) State

This emotional state is identified through the observation of diverse facial expressions.

Indicators: raised nose and forehead, one eyebrow elevated higher than the other, and compressed lips.

Concentration State:

This state is associated with tasks requiring the individual to ignore potential environmental distractions.

Indicators: reduced blinking, fixed gaze, and slightly raised eyebrows.

Nervousness State

This emotional state is characterized by rapid facial movements associated with emotional tension (e.g., lip biting).

Indicators: neutral eyes, with one side of the lips raised and slightly pulled backward.

We focus on the functions of facial landmark points and the distances between them, as these facilitate the automatic recognition of facial expressions while considering users' emotional states, such as happiness, confusion, concentration, and nervousness. The following measurements and functions used for emotion recognition were analyzed: facial description functions, facial landmark extraction functions, and distance measurement functions between facial regions. We propose an emotion-based facial image recognition system

capable of effectively identifying emotions through the detection of specific facial landmarks and the distances among them.

Facial landmarks are defined according to the following distinctive regions:

eye region;

mouth region;

nose region;

forehead region;

and others.

To extract these characteristics, it is necessary to analyze feature sets related to landmark points and the distances between facial objects.

Landmark Feature Set:

We extract three sets of functions corresponding to characteristic landmark points that represent the average measurements of specific facial regions.

RESEARCH METHODOLOGY

Over the past decade, spontaneous facial expressions have played a significant role in recognizing human emotions. In the field of facial recognition, image analysis using various algorithms and models has attracted considerable attention from researchers as one of the most promising directions. In this process, human-computer interaction plays an essential role, where factors such as the characteristics and spatial arrangement of facial features, as well as the manifestation of emotions on the human face, are of particular importance. Over the years, various methods for facial identification have emerged. Many researchers emphasize that the most effective approaches are based on recognizing facial appearance while simultaneously identifying the internal emotional states of individuals and associating them with personal identity information.

Typically, these methods consider a range of fundamental human emotions, including excitement, happiness, hesitation, fear, concentration, nervousness, and others. Many facial expression recognition techniques rely on geometric facial features. The methods used for facial expression analysis are commonly based on the Facial Action Coding System (FACS), developed by researchers Paul Ekman and Wallace V. Friesen, in which each facial expression is represented by specific Action Units (AUs). The Facial Action Coding System (FACS) is a widely recognized and systematic approach for analyzing facial expressions. It provides a detailed and objective framework for describing facial movements and offers deeper insight into the complex language of human emotions. Facial expressions play a crucial role in human communication by conveying a wide spectrum of emotions and intentions. FACS was introduced as a tool that allows researchers and practitioners to systematically decode and categorize subtle facial movements.

ANALYSIS AND RESULTS

Distance-Based Feature Set: We further derive meaningful features from the distance-based feature set. As a result of this process, three primary distances are identified: the distance related to the eye region, the distance related to the mouth region, and the displacement movement of the head. Using the line equation between points ([x1,x2],[y1,y2]), a line is drawn from one coordinate to another. Based on these two points, the distance L between the coordinates is calculated as follows:

$$L = \sqrt{[(x_2)^2 - (x_1)^2]} \text{ (equation)} \quad (1)$$

Analysis of the Proposed System

The operating principle of the proposed system, as illustrated in Figure 2, consists of image analysis and feature extraction based on facial landmarks and distance measurements. If facial movement is detected, the system produces an output corresponding to the identified emotional state. A more detailed explanation is provided below. In the development of the proposed system, its semantic model was designed using a branching algorithm approach (Figure 1 presents the semantic network model of the system).

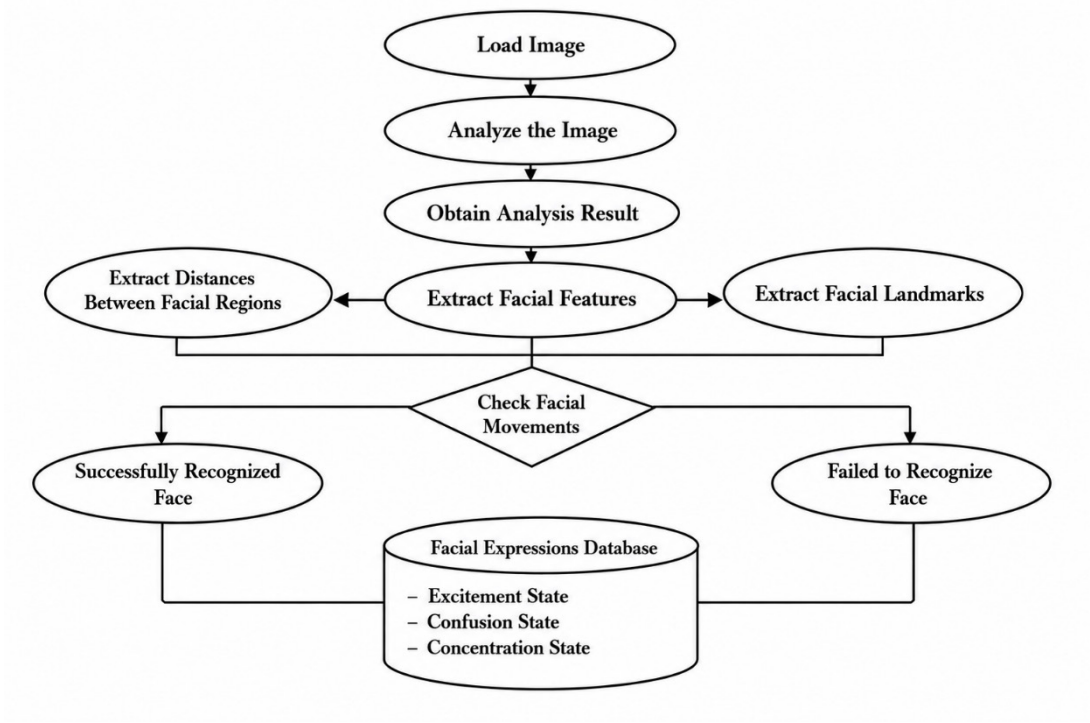

Figure 1. Semantic Network Model of the System

In the proposed system described above, an image containing the facial expression of the target individual (student, learner, or cadet) is uploaded into the system. The uploaded image is analyzed by separating it into different parameters. The emotional states of the face are examined, since the individual's face may appear in various conditions and orientations within the image.

After performing all analytical functions, the system compares the extracted facial expressions with those stored in its own database or in an integrated external database. Consequently, the system identifies the facial expression of the individual (student, learner, or cadet) appearing in the uploaded image or in front of the camera, together with all associated personal information, including full name, year of birth, nationality, and other relevant data.

Furthermore, when a user attempts to access an e-platform profile, the system automatically authenticates whether the person accessing the profile is indeed the legitimate owner. If another individual attempts unauthorized access to the profile (for example, when a different person tries to take an examination on behalf of the profile owner), the system automatically restricts access privileges and prevents unauthorized login attempts.

CONCLUSION AND SUGGESTIONS

In conclusion, the Facial Action Coding System (FACS) makes a substantial contribution to the study of facial expressions and human emotions. Its impact extends across multiple disciplines, ranging from psychology to advanced technological systems, thereby shaping our understanding of non-verbal communication. As technology continues to evolve, the use of FACS terminology and methodologies serves as a fundamental basis for further advancements in this field.

In the automatic recognition of facial expressions, it is particularly important to analyze changes in facial movements while considering students' emotional states within educational environments. The proposed system can, in the future, provide continuous monitoring of students' emotional conditions, record emotional changes through video-based data storage, and enable subsequent analysis and supervision.

To achieve this objective, it is essential to establish fully automated monitoring systems in examination centers in order to minimize the misuse of students' official identities and profiles. Such automated systems can be integrated into all educational e-platforms. In this context, the facial expression identification model proposed in this study can be effectively utilized during e-platform authentication processes, since human facial expressions vary over time depending on mood, psychological state, and internal emotional conditions.

References

1. Cohen I, Sebe N, Garg A, Lew M S and Huang T S 2003 Facial Expression Recognition From Video Sequences Computer Vision and Image Understanding 91(1-2) 160-187p
2. Valenti R, Sebe N and Gevers T 2007 Facial Expression Recognition: A Fully Integrated Approach Image Analysis and Processing Workshops IEEE DOI 10.1109/ICIAPW.2007.25
3. Paleari M, Huet B and Chellali R 2010 Towards Multimodal Emotion Recognition: New Approach ACM International Conference on Image and Video Retrieval
4. Paleari M, Chellali R and Hue B 2010 Features for Multimodal Emotion Recognition:An Extensive Study Cybernetics and Intelligent Systems (CIS) IEEE DOI:10.1109/ICCIS.2010.5518574
5. Hsu F S, Lin W Y and Tsai T -W 2014 Facial expression recognition using bag of Distances Multimedia Tools and Applications73(1) 309–326
6. Saneiro M, Santos O C, Salmeron-Majadas S and Boticario J G 2014 TowardsEmotion Detection in Educational Scenarios from Facial Expressions and Body Movements through Multimodal Approaches The Scientific World Journal DOI: 10.1155/2014/484873
7. Moridis C N and Economides E A 2009 Mood Recognition during OnlineSelf Assessment Tests IEEE Transactions on Learning Technologies 2(1) 50-61
8. Lucey P, Cohn J F, Kanade T,Saragih J and Ambadar Z 2010 Extended Cohn-Kanade Dataset (CK+): A complete dataset for action unit and emotion specified expression Computer Vision and Pattern Recognition Workshops (CVPRW) DOI: 10.1109/CVPRW.2010.5543262
9. Tomasi C and Kanade T 1991 Detection and Tracking of Point Features Technical Report CMU-CS-91-132
10. Akputu K O, Seng K P and Lee Y L 2013 Facial Emotion Recognition for Intelligent Tutoring Environment 2nd International Conference on Machine Learning and Computer Science (IMLCS)

Proofreader: Zokir ALIBEKOV

Layout and Designer: Oloviddin Sobir ugli

2026. № 5

To publish articles in this journal, you may submit articles, advertisements, stories, and other creative materials through the following links. Materials and advertisements are published on a paid basis.

You may subscribe to the journal at any time using the following details. Once subscribed, please send a screenshot or photo of your payment confirmation to our Telegram page @iqtisodiyot_77. Based on this, we will send the latest issue of the journal to your address each month.

"The journal "INNOVATION SCIENCE AND TECHNOLOGY" has been registered by the Agency for Information and Mass Communications under the Administration of the President of the Republic of Uzbekistan from 09.10.2024 under the registration number №390637. License number: C-5669633. PNFL: 30407832680027

Our address: Tashkent city, Yunusobod district, 19th block, House 17.

TASHKENT STATE UNIVERSITY OF ECONOMICS

Acceptance of articles

Published every monthly

Directions

Social, economic, political, technological, scientific

Scopus || Scientific electronic journal specializing in Scopus

CERTIFICATE NUMBER: №390637

ORDER NUMBER ACCORDING TO THE LICENSE REGISTER: C-5669633

CONTACT:

Contact us
+998 50 737 87 88

Telegram channel
t.me/scopus_IST2100

Journal official website
https://ist-journal.uz/index.php/IST