# 얼굴 표정 인식 기술의 동향과 향후 방향: 텍스트 마이닝 분석을 중심으로

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# Trends and Future Directions in Facial Expression Recognition Technology: A Text Mining Analysis Approach

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**요 약**

Facial expression recognition technology's rapid growth and development have garnered significant attention in recent years. This technology holds immense potential for various applications, making it crucial to stay up-to-date with the latest trends and advancements. Simultaneously, it is essential to identify and address the challenges that impede the technology's progress. Motivated by these factors, this study aims to understand the latest trends, future directions, and challenges in facial expression recognition technology by utilizing text mining to analyze papers published between 2020 and 2023. Our research focuses on discerning which aspects of these papers provide valuable insights into the field's recent developments and issues. By doing so, we aim to present the information in an accessible and engaging manner for readers, enabling them to understand the current state and future potential of facial expression recognition technology. Ultimately, our study seeks to contribute to the ongoing dialogue and facilitate further advancements in this rapidly evolving field.

## 1. Introduction

Facial expression recognition technology has experienced rapid advancements in recent years, significantly expanding its potential for applications across various fields. In particular, the development of artificial intelligence has led to facial expression recognition technology incorporating deep learning, machine learning, and image processing techniques to extract highly detailed information from human faces, enabling it to recognize expressions with remarkable accuracy.

The progression of this technology showcases its potential applicability in various sectors, including everyday human life, security, medical, transportation, and military domains. This paper delves into the analysis of text mining results derived from facial expression recognition technology-related papers published between 2020 and 2023 to gain insights into the most recent trends and developmental trajectories. In doing so, we discuss how the technology evolves, the existing technical limitations hindering its progress, and potential strategies to overcome these obstacles.

The structure of this paper is organized as follows: Section 2 delineates the research background and methodology adopted in this study, Section 3 presents the experimental results derived from our analysis, and Section 4 offers a comprehensive discussion and draws conclusions based on our findings.

## 2. Research Background

Facial expression recognition technology is one of the essential technologies in the field of artificial intelligence. It extracts subtle details that humans may not see with the naked eye, allowing machines to understand and make appropriate decisions based on this information. This technology is currently being utilized in various fields and continues to develop further.

In recent years, facial expression recognition technology has employed deep learning, computer vision, and machine learning techniques to extract highly detailed information from human faces and recognize expressions based on this data. The advancement of this technology is one of the primary reasons why facial expression recognition is now applied in various fields.

This study analyzes the trends in facial expression recognition technology based on the text mining results from

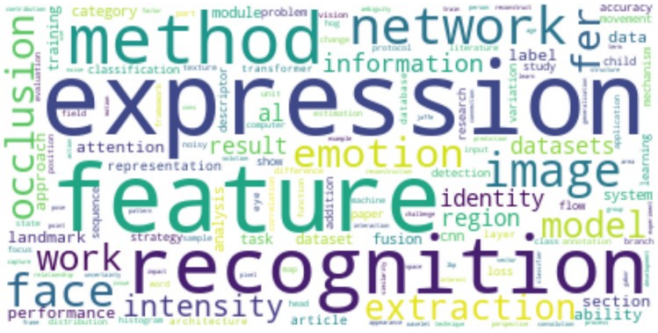
<Table 1> List of References of the Analyzed Papers.

| No. | Authors | Year | Title | Journal |
|---|---|---|---|---|
| 1 | Liu et al. | 2021 | Facial Expression Recognition Using Hybrid Features of Pixel and Geometry | IEEE Access |
| 2 | Shi et al. | 2021 | A Facial Expression Recognition Method Based on a Multibranch Cross-Connection Convolutional Neural Network | IEEE Access |
| 3 | Lakshmi and Ponnusamy | 2021 | Facial emotion recognition using modified HOG and LBP features with deep stacked autoencoders | Microprocessors and Microsystems |
| 4 | Zhang et al. | 2020 | Identity–Expression Dual Branch Network for Facial Expression Recognition | IEEE Transactions on Cognitive and Developmental Systems |
| 5 | Chen et al. | 2021 | Toward Children's Empathy Ability Analysis: Joint Facial Expression Recognition and Intensity Estimation Using Label Distribution Learning | IEEE Transactions on Industrial Informatics |
| 6 | Zhang et al. | 2022 | MAN: Mining Ambiguity and Noise for Facial Expression Recognition in the Wild | Pattern Recognition Letters |
| 7 | Poux et al. | 2021 | Dynamic Facial Expression Recognition Under Partial Occlusion With Optical Flow Reconstruction | IEEE Transactions on Image Processing |
| 8 | Liu et al. | 2023 | FEDA: Fine-grained emotion difference analysis for facial expression recognition | Biomedical Signal Processing and Control |
| 9 | Ma et al. | 2021 | Facial Expression Recognition with Visual Transformers and Attentional Selective Fusion | IEEE Transactions on Affective Computing |

2020 to 2023, providing a comprehensive overview and research trends in this area. We discuss the extent to which the current facial expression recognition technology has developed and how it recognizes expressions. Additionally, we conduct text mining for each component of the papers to examine which parts can best capture research trends in facial expression recognition technology. The list of papers used in this study is provided in Table 1 below.

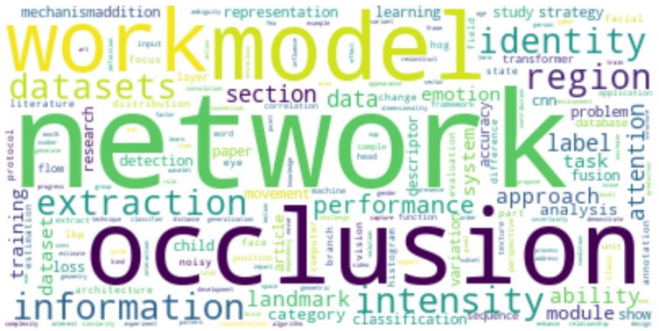
## 3. Experimental Results

In Figure 1, we can see that words such as FER (Facial Expression Recognition), which have the same meaning but in different forms, have a high frequency. We thought these words could hinder frequency analysis, so we removed them and created a word cloud for further analysis.



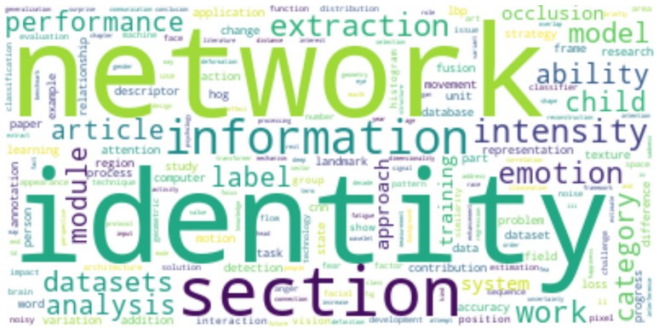

**(Figure 1)** Word Cloud Visualization of the Analyzed Papers.

In the results shown in Figure 2, we can observe that the frequency of deep learning-related words such as network and model is high, and the frequency of occlusion, an important issue in facial expression recognition technology, is also high, indicating that it is one of the critical challenges to be addressed. Moreover, we found that technologies like landmarks and attention mechanisms have been widely used recently, and emotion intensity estimation is prevalent in emotion classification.



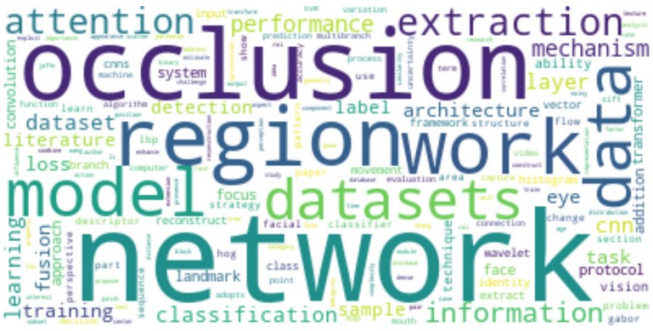

**(Figure 2)** Word Cloud of the Analyzed Papers with Frequent Words Removed.

From the analysis of the papers used in this study, we can see that the frequency of the word identity is the highest due to a paper using the Identity-Expression Dual Branch Network [4] technology. In the introduction section, we can infer that the widespread introduction of the technology to be used in the paper is provided, and the word section indicates how the paper is structured as shown in Figure 3.



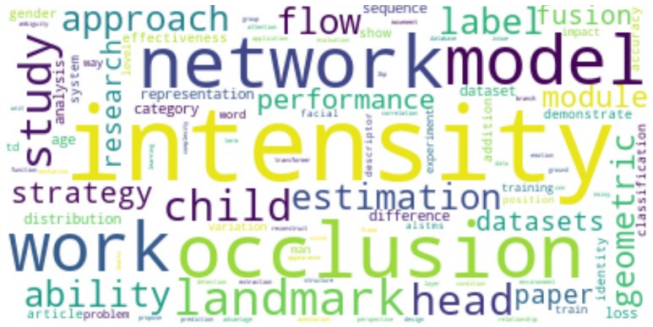

**(Figure 3)** Word Cloud Visualization of Introduction Sections from the Analyzed Papers.

In Figure 4, we can see that the introduction of datasets used in related studies and the datasets to be used in the paper are primarily discussed. We can also identify which deep learning technologies, such as network, model, and attention mechanism, are available to address the occlusion problem, which still needs to be resolved in previous studies.



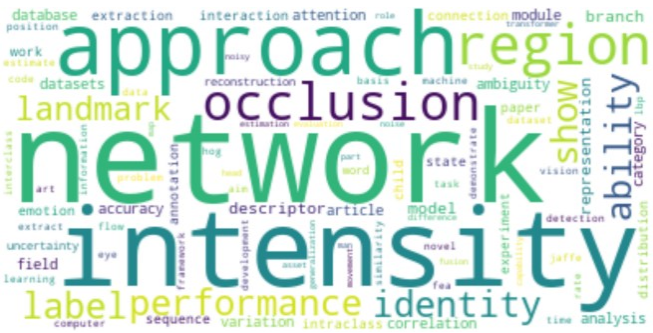

**(Figure 4)** Word Cloud Visualization of Related Work Sections from the Analyzed Papers.

In Figure 5, we can observe the term "head" (referring to the challenge of analyzing images where the head is not directly facing the camera) as one of the problems mentioned alongside occlusion. As this term appears in the conclusion section, it highlights key issues that must be addressed to drive the future advancement of facial expression recognition technology.




**(Figure 5)** Word Cloud Visualization of Conclusion Sections from the Analyzed Papers.

In Figure 6, we can observe the high frequency of the deep learning-related term "network." As this figure represents the summary section, it briefly outlines the challenges faced by facial expression recognition technology, such as occlusion, and the approaches employed to tackle them, including landmark and deep learning techniques. This comprehensive analysis offers a logically coherent and detailed overview of the current state of facial expression recognition technology and the obstacles that must be overcome in the future.




**(Figure 6)** Word Cloud Visualization of Abstract Sections from the Analyzed Papers.

## 4. Conclusions

Motivated to understand the evolving landscape of facial expression recognition technology, we conducted a text-mining analysis of research papers published between 2020 and 2023. Our findings indicate that the current development direction predominantly involves deep learning techniques such as landmark and attention mechanisms. Moreover, we identified pressing challenges the field faces, including occlusion and head-related issues, which must be addressed in the future. By performing text mining on various sections of these papers, we were able to derive valuable insights. Specifically, the summary sections provided an overview of the proposed approaches to tackle existing challenges, while the conclusion sections shed light on the issues requiring ongoing attention and resolution. Consequently, reviewing the summary and conclusion sections is instrumental in understanding the overall trends and future directions in facial expression recognition technology.

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