# Literature Review

1. **Introduction**

* Facial Expression Recognition (FER) plays a critical role in human-computer interaction, allowing machines to interpret human emotions. Traditional FER models, trained on closed-set datasets, typically recognize a fixed number of basic emotions. However, in real-world applications, emotions often fall outside these predefined categories, such as compound or unknown emotions, posing a significant challenge. This challenge, known as Open-Set FER, refers to the ability of models to correctly identify new, unseen emotions without misclassification.

1. **Body**

#### **Challenges in Open-Set FER**

One of the primary challenges in FER is distinguishing between known and unknown emotions. Existing models often misclassify unknown expressions as one of the known categories because of the minimal difference between facial expressions. Deep learning-based FER models also suffer from overconfidence in their predictions, even when encountering unseen data. Methods like DIAS and OpenMax, which were designed for open-set recognition, fail to perform adequately in FER due to the small inter-class distances between emotions.

#### **Proposed Solutions: Attention Map Consistency and Cycle Training**

To address these challenges, recent advancements in Open-Set FER propose transforming the problem into noisy label detection. The use of attention map consistency ensures that the model focuses on critical facial regions across different transformations, improving robustness. Cycle training is another novel technique where two models are alternately trained using pseudo labels, refining their understanding of known and unknown expressions.

#### **Pseudo Labels for Open-Set Detection**

In Open-Set FER, pseudo labels are generated for both known and unknown samples. Unlike traditional models with clean labels, pseudo labels for unknown samples are distributed across several known categories, creating noisy labels. This distributed labeling helps the model differentiate between known and unknown expressions, treating unknown samples as outliers.

#### **Comparison with Existing Methods**

Previous approaches to FER, such as those by Li et al. (2017) and Farzaneh et al. (2021), focused on improving closed-set recognition. These methods used techniques like crowdsourcing-based emotion simulation and center loss to enhance intra-class similarity and inter-class separation. However, they failed to generalize to open-set recognition tasks. The proposed method, by converting Open-Set FER into noisy label detection, outperforms existing methods like DIAS and OpenMax , particularly in distinguishing subtle emotional differences.

#### **Experiments and Results**

Experiments on datasets such as RAF-DB, FERPlus, and AffectNet show significant improvements in Open-Set FER using attention map consistency and cycle training. The method achieves higher AUROC scores and lower FPR@TPR95 values compared to existing methods. Additionally, the model demonstrates robust performance in online applications, with only a 2.6% drop in accuracy for real-time emotion detection.

1. **Conclusion**

* Open-Set FER presents unique challenges due to the minimal distance between emotion categories. By transforming the recognition of unknown emotions into a noisy label detection problem, and leveraging techniques like attention map consistency and cycle training, significant improvements in emotion detection are achieved. The proposed methods not only enhance accuracy in distinguishing between known and unknown emotions but also provide a more reliable solution for real-world FER applications.

## Overview of example structure and sentences

|  |
| --- |
| **Aspect** |
| **Topic sentence**  The introduction of Open-Set FER approaches revolutionized emotion detection by allowing models to adapt to unseen categories. |
| **Pivotal study**  In light of these limitations, Zhang et al. (2021) introduced Open-Set FER, which frames the challenge of detecting unseen emotions as a noisy label problem. Their research found that methods like AMC significantly outperformed traditional closed-set models. |
| **Critical evaluation**  However, while Open-Set FER offers promising improvements, challenges remain in distinguishing fine-grained emotional distinctions due to the inherent closeness between human emotions. This proximity between emotional categories makes separating known from unknown expressions difficult. |
| **Theory**  Zhang et al. (2021) proposed using Cycle Training and Attention Map Consistency to mitigate this issue by exploiting the subtle differences between emotions. They argued that by cycling through models with varying noise levels, the system could better distinguish unknown emotions from known ones. |
| **Synthesis**  Empirical evaluations of Open-Set FER methods, such as Zhang's 2021 study, confirmed that these techniques outperform existing closed-set FER models. For instance, Zhang et al. demonstrated that AMC improved AUROC by more than 20% when compared to DIAS and OpenMax. |
| **Gap**  Nevertheless, more research is required to determine how Open-Set FER models handle compound emotions (e.g., confusion mixed with anger) or cultural variations in emotional expressions, which could further impact the model’s ability to generalize effectively. |