

**Deep Learning-Based Facial Expression Recognition for
Analysing Learner Engagement in Multimedia
Enhanced Teaching**

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Recent advancements in technology have created numerous opportunities to provide learners with diverse devices and solutions that enhance the learning experience. Assessing learners' engagement in TEL through a mulsemmedia-enhanced approach is essential to maximize learning outcomes, improve learner satisfaction, and optimize educational resources and strategies tailored to learners' needs. However, existing mulsemmedia-based approaches have not significantly assessed learner engagement levels. This research proposes a FER approach to analyze learner engagement and satisfaction in mulsemmedia-based learning.

Current FER systems, however, face challenges such as overfitting and difficulties in accurately predicting expressions in real-time environments. Specific limitations of existing FER systems include the following: detecting faces under varying head poses, illumination conditions, and occlusions remains challenging, especially with the Viola-Jones face detection algorithm. Additionally, while most FER systems rely on spatial features, real-time FER recognition requires both spatial and temporal features, which current models often lack. Furthermore, supervised FER approaches require extensive datasets to train models effectively, and imbalances in facial expression counts can further impact model performance.

There is significant potential for future research in analyzing learners' emotions and enhancing learning approaches within mulsemmedia learning environments. Some of the key areas for exploration are listed below:

- **Emotion Recognition and Mulsemmedia:** Emotion recognition combined with mulsemmedia learning holds the potential to create highly personalized and immersive educational experiences. By understanding a learner's emotional state, a mulsemmedia system can dynamically adjust the sensory stimuli to optimize learning outcomes. For example, if a student is detected to be frustrated, the system might reduce the complexity of a task or provide soothing sensory inputs to alleviate stress.
- **Creating New FER Databases:** Developing various new facial expression recognition databases that specifically include facial expressions related to learning

activities can enhance the accuracy and applicability of FER systems in educational settings.

- **Adaptive Learning Systems:** Generative AI (GEN AI) models can help in creating adaptive learning systems that adjust content and delivery based on the learner's emotional state, thus improving engagement and effectiveness. These systems can personalize learning paths and provide targeted feedback to meet individual learner needs.
- **Composite Facial Expression Research:** Composite facial expression recognition has significant investigational promise, but there are only a few studies on it, and their results are not outstanding. Further research in this area is needed to improve the identification and interpretation of composite facial expressions, which can provide deeper insights into learners' emotional states.
- **Immersive Learning Content:** Introducing multimedia content grounded in immersive learning approaches, such as mixed reality and the metaverse, has the potential to revolutionize education by offering highly engaging and realistic learning experiences. These technologies can create virtual environments that simulate real-world scenarios, making the learning process more interactive and effective.