

Title

Facial Emotion Recognition System for Enhanced Educational Engagement:
Project Report

Student Info

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Abstract

The growing demand for understanding students' emotional engagement in educational settings has motivated the development of advanced facial emotion recognition systems. Traditional evaluation tools fail to capture real-time emotional states crucial for adapting pedagogical strategies. This project proposes a Convolutional Neural Network (CNN)-based platform utilizing ResNet-18 architecture with Squeeze-and-Excitation (SE) modules, trained on datasets such as FER-2013, AffectNet, and RAF-DB. The aim is to deliver real-time emotion detection for classrooms, providing actionable feedback to instructors. The system's success is measured by performance metrics like accuracy, precision, and F1-Score. Tools including TensorFlow and OpenCV will be employed for implementation. The expected outcome is a robust, ethical, real-time educational emotion analysis system that enhances learning outcomes and personalizes education.

1. Introduction

Emotions significantly influence learning, memory retention, and classroom engagement. Despite this, traditional assessment methods largely ignore emotional feedback. Emotion Recognition Technologies (ERTs), powered by Artificial Intelligence (AI) and computer vision, provide an opportunity to bridge this gap. Implementing real-time facial emotion recognition systems in education could revolutionize teaching by enabling dynamic adaptation based on students' emotional states. However, challenges like cultural sensitivity, data privacy, and real-time processing remain. This report

introduces a project that seeks to address these issues through a novel CNN-based system.

2. Problem Specification

The core problem addressed is the lack of real-time, automated systems for accurately recognizing and analyzing students' emotions during lectures.

- Problem Statement: Develop a robust facial emotion recognition system for educational settings to provide real-time emotional feedback to instructors.
- Scope: Focus on facial-based emotion recognition without incorporating body gesture data in this phase.
- Constraints: Data privacy must be preserved; system must operate in real-time environments.
- Type: Classification (categorizing facial expressions into discrete emotions).

3. Motivations

- Real-world applications: Real-time adjustment of teaching strategies based on student emotions.
- Academic significance: Fills the research gap in integrating AI-based emotional analysis into active educational environments.
- Industry interest: High demand for adaptive learning technologies in EdTech.
- Personal motivation: Commitment to enhancing educational quality through technological innovation.

4. Objectives

- Primary Objective: Build and evaluate a real-time facial emotion recognition system tailored for classroom environments.
- Secondary Objectives:
 - Implement and optimize CNN models with SE modules.
 - Benchmark performance across multiple datasets.
 - Maintain strict ethical standards regarding data handling.
- Long-term Impact: Enable widespread adoption of emotion-sensitive educational technologies.

5. Literature Review

Several studies have influenced this project:

- Salloum et al. (2025): Achieved 95% emotion classification accuracy using a refined CNN with preprocessing and augmentation.
- Diwan et al. (2024): Emphasized holistic emotion recognition combining facial and body gestures, highlighting generalizability issues.
- Indra Saputra et al. (2024): Demonstrated the role of real-time emotion feedback in improving teaching outcomes.
- Katirai (2023): Highlighted critical ethical considerations, stressing privacy and potential algorithmic biases.

In contrast to existing works, our project focuses on robust generalization across demographics and operational readiness for educational settings.

6. Proposed Methodology

- Model: CNN based on ResNet-18 architecture with Squeeze-and-Excitation (SE) modules.
- Justification: ResNet-18 provides efficient depth, while SE modules enhance feature selection, improving emotion classification accuracy.
- Preprocessing Steps:
 - Face detection and alignment.
 - Normalization and augmentation (rotation, flipping).
 - Handling class imbalance with oversampling techniques.
- Tools and Libraries:
 - TensorFlow (for model development).
 - OpenCV (for face detection and video processing).
 - Scikit-learn (for evaluation metrics).

7. Datasets Description

- FER-2013: 35,887 grayscale facial images (48x48 pixels) categorized into seven emotions.
- AffectNet: 1 million facial images, ~450,000 manually annotated across eight emotion classes.
- RAF-DB: 29,672 real-world facial images with basic and compound expression annotations.

Planned Preprocessing:

- Normalize pixel intensities.

- Augment datasets for class balance.
- Remove low-quality images.

Challenges:

- High variance in facial angles and lighting.
- Cultural differences in emotional expression.

8. Timeline of Second Semester Project (10 Weeks)

Week	Planned Activity
1	Finalize literature review, environment setup
2	Data preprocessing and exploratory analysis
3	Implement baseline CNN model
4	Evaluate baseline model and identify weaknesses
5	Implement main model (ResNet-18 + SE modules)
6	Fine-tune hyperparameters
7	Collect evaluation metrics (accuracy, F1-Score)
8	Comparative analysis with baseline
9	Draft final project report and prepare presentation
10	Final review, presentation, and submission

9. References

1. Salloum, S. A., et al. (2025). Emotion recognition for enhanced learning: using AI to detect students' emotions. Smart Learning Environments.
2. Diwan, A., et al. (2024). Advancements in Emotion Classification via Facial and Body Gesture Analysis. Expert Systems.
3. Indra Saputra, K., et al. (2024). The Evolution of Educational Assessment: How Artificial Intelligence is Shaping Learning Evaluation. Indonesian Journal of Computer Science.
4. Katirai, A. (2023). Ethical considerations in emotion recognition technologies: a review. AI and Ethics.
5. Möller, C., et al. (2022). Culture shapes preschoolers' emotion recognition. Journal of Cultural Cognitive Science.

Facial Emotion Recognition System for Enhanced Educational Engagement: Final Report

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Abstract

Understanding students' emotional engagement during lectures is critical for educational success. Traditional assessment methods overlook real-time emotional states, limiting instructors' ability to adapt teaching strategies. This project proposes a CNN-based facial emotion recognition system utilizing ResNet-18 with Squeeze-and-Excitation (SE) modules, trained on FER-2013, AffectNet, and RAF-DB datasets. Implemented using TensorFlow and OpenCV, the system delivers real-time emotional feedback to educators. Evaluation metrics such as accuracy, precision, and F1-Score will be used to measure system performance. The expected outcome is a practical and ethical platform enhancing student learning outcomes.

1. Introduction

Emotions influence cognitive processes such as attention, memory, and learning. Traditional evaluation frameworks miss emotional dynamics during lectures. Emotion Recognition Technologies (ERTs) powered by AI offer a pathway to integrate real-time feedback into educational settings. Despite the potential, challenges like cultural sensitivity, ethical concerns, and technical robustness remain. This project aims to develop an effective, real-time facial emotion recognition system addressing these issues.

2. Problem Specification

- Problem Statement: Develop a real-time, robust facial emotion recognition system for educational settings.
- Scope: Focus exclusively on facial expressions without using body gesture data.

- Constraints: Preserve student privacy and ensure real-time processing.
- Type: Classification task (categorizing facial expressions into discrete emotions).

3. Motivations

- Real-world Application: Adaptive teaching based on student emotions.
- Academic Significance: Bridges AI with real-time education feedback.
- Industry Interest: High demand in EdTech solutions.
- Personal Motivation: Passion for enhancing education through innovative technologies.

4. Objectives

- Primary Objective: Develop and evaluate a real-time facial emotion recognition system for classrooms.
- Secondary Objectives:
 - Implement and optimize CNN models with SE modules.
 - Benchmark model performance across datasets.
 - Ensure ethical handling of data and results.
- Long-Term Impact: Enable emotion-aware, personalized learning experiences.

5. Literature Review

- Salloum et al. (2025): Achieved 95% emotion classification accuracy with refined CNN.
- Diwan et al. (2024): Highlighted the need for multimodal emotion recognition.
- Indra Saputra et al. (2024): Emphasized the impact of real-time emotional feedback.
- Katirai (2023): Discussed critical ethical issues related to emotion recognition.

This project differentiates itself by focusing on operational readiness and demographic robustness in educational settings.

6. Proposed Methodology

- Model: CNN based on ResNet-18 with Squeeze-and-Excitation modules.
- Justification: ResNet-18 offers efficient depth; SE modules improve feature recalibration.
- Preprocessing:
 - Face detection and alignment.

- Pixel normalization.
- Data augmentation (flipping, rotation).
- Oversampling to address class imbalance.
- Libraries: TensorFlow, OpenCV, Scikit-learn.

7. Datasets Description

- FER-2013: 35,887 grayscale images across 7 emotions.
- AffectNet: ~1 million images, 450,000 manually annotated.
- RAF-DB: 29,672 real-world annotated facial images.

Challenges: High variance in facial expressions, lighting conditions, and cultural differences in emotional expression.

8. Timeline of Second Semester Project (10 Weeks)

Week 1-2: Finalize literature review, environment setup

Week 3-4: Data preprocessing and exploratory analysis

Week 5-6: Implement baseline CNN model

Week 7-8: Evaluate and refine models

Week 9-10: Draft final project report and submission

9. References

1. Salloum, S. A., et al. (2025). Emotion recognition for enhanced learning.
2. Diwan, A., et al. (2024). Advancements in Emotion Classification.
3. Indra Saputra, K., et al. (2024). AI in Educational Assessment.
4. Katirai, A. (2023). Ethical considerations in emotion recognition technologies.
5. Möller, C., et al. (2022). Cross-cultural study on emotion recognition.

Facial Emotion Recognition in Educational Settings: Project Report

1. Dataset Description and Size

The proposed project will utilize a combination of three prominent facial emotion recognition datasets:

- FER-2013: Contains approximately 35,887 grayscale images (48x48 pixels) categorized into seven emotion classes: anger, disgust, fear, happiness, sadness, surprise, and neutral.
- AffectNet: One of the largest datasets with over 1,000,000 facial images, about 450,000 manually annotated for eight emotions: neutral, happy, sad, surprise, fear, disgust, anger, and contempt.
- RAF-DB: Comprises 29,672 real-world facial images annotated with basic and compound expressions across diverse demographics.

By integrating these datasets, the model will benefit from diverse, extensive training data, enhancing its generalization capabilities.

2. Preliminary Literature Review and Next Steps

Recent studies show significant advancements in emotion recognition:

- Salloum et al. (2025): Developed a CNN model achieving 95% accuracy using preprocessing and augmentation.
- Diwan et al. (2024): Highlighted the importance of combining facial and body gesture data.
- Indra Saputra et al. (2024): Advocated for real-time emotional feedback to enhance educational outcomes.

Next Steps:

- Implement CNN with transfer learning.
- Incorporate multimodal data (facial expressions and gestures).
- Develop real-time emotional feedback systems.

3. Proposed Machine Learning Model and Methodology

The proposed model will be a Convolutional Neural Network (CNN) based on ResNet-18 architecture with Squeeze-and-Excitation (SE) modules.

- CNN (ResNet-18): Captures spatial hierarchies with residual connections.
- SE Modules: Improve feature recalibration for enhanced emotion detection.
- Transfer Learning: Pre-training on AffectNet, fine-tuning on RAF-DB and FER-2013.

This combination aims for a robust and efficient emotion recognition system capable of real-time operation.

4. Project Timeline (Weekly Plan)

Week	Task
1-2	Finalize project idea and form groups
3	Submit detailed research proposal
4-5	Conduct literature review
6-7	Data collection and preprocessing
8	Preliminary data analysis and step planning
9-10	Model implementation and initial training
11	Model evaluation and refinement
12	Final presentation and project delivery

5. Model Evaluation and Performance Metrics

The model's performance will be assessed using:

- Accuracy: Overall correct predictions.
- Precision: Exactness of positive predictions.
- Recall: Ability to identify all relevant instances.
- F1-Score: Balance between precision and recall.

- Confusion Matrix: Detailed breakdown of prediction results.
- Cross-Validation: To ensure robustness across data subsets.

These evaluation methods will guide improvements, ensuring practical applicability of the model in educational environments.

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