Age and Emotion Detection for Movie Theatre

1. Introduction

The integration of artificial intelligence (AI) into various industries has opened new possibilities for enhancing security, personalization, and customer experience. One such application is Age and Emotion Detection for Movie Theatres, which ensures compliance with age-restricted content regulations while enhancing audience engagement. This project utilizes computer vision and deep learning to detect a person's age and emotional state in real time using Convolutional Neural Networks (CNNs) and OpenCV.

2. Background

Movie theatres are required to restrict access to age-inappropriate content based on government and industry regulations. Additionally, understanding audience emotions can help cinemas gauge real-time reactions to movies and improve customer satisfaction. Traditional methods like manual ID verification and surveys are inefficient and prone to errors. This project automates the process by using AI-powered face detection to classify age and emotions instantly.

3. Learning Objectives

The primary objectives of this project are:

- Implement face detection using Haarcascade in OpenCV.
- Develop a CNN-based model to predict age and emotions.
- Apply real-time video processing to detect and analyze faces.
- Establish a decision-making system for access control based on age.
- Store data logs in a CSV file for further analysis.
- Enhance knowledge of deep learning, OpenCV, and model deployment.

4. Activities and Tasks

The project involved multiple key activities:

✅ Dataset Preparation: Collected and preprocessed images from the UTKFace and FER2013 datasets.

✅ Model Training: Developed separate CNN models for age and emotion classification.

✅ Face Detection Integration: Used Haarcascade_frontalface_default.xml for real-time face detection.
✅ Age and Emotion Prediction: Implemented models in OpenCV to classify detected faces.
✅ Decision Making:

- Red Box + "Not Allowed" for age below 13 or above 60.
- Green Box + Age & Emotion Display for age between 13-60.
  ✅ CSV Logging: Stored valid detections (age & emotion) for later analysis.
  ✅ Testing and Deployment: Evaluated performance using real-world webcam footage.

5. Model Performance & Accuracy

During training and validation, the performance of both models was measured:

Emotion Detection Model

- Training Accuracy: 79%
- Testing Accuracy: 68%

Age Detection Model

- Validation Mean Absolute Error (MAE): 8.1397

These accuracy levels indicate that while the emotion model performed reasonably well, there was a performance gap of 11% between training and testing accuracy, suggesting potential overfitting. The age model's MAE of 8.1397 means that predicted ages can have an average error of around 8 years.

6. Skills and Competencies Developed

By working on this project, the following technical and analytical skills were developed:
📌 Machine Learning & Deep Learning – Training and optimizing CNN models.
📌 Computer Vision (OpenCV) – Face detection and real-time video analysis.
📌 Python Programming – Implementing AI models with TensorFlow and Keras.
📌 Data Preprocessing – Handling image datasets for deep learning.
📌 Decision Making with AI – Implementing logic for access control.
📌 Data Logging & Analysis – Storing and analyzing CSV-based logs.

7. Feedback and Evidence

- Testing Results: The application successfully detected age and emotions with moderate accuracy.
- Real-time Performance: Processing speed was optimized to run at ~20 FPS on a standard laptop.
- User Feedback: Initial feedback from testers indicated that the system was able to accurately identify emotions like happy, sad, neutral, and angry, but sometimes misclassified complex emotions.
- CSV Logs: Data collection enabled insights into audience reactions over time.

8. Challenges and Solutions

Challenges	Solutions
Low Lighting Conditions	Implemented adaptive brightness correction.
Face Occlusion (Hats, Glasses, etc.)	Used data augmentation during model training to improve robustness.
Real-time Processing Delays	Optimized model inference using TensorFlow Lite and batch processing.
Age Estimation Errors (MAE = 8.1397)	Improved accuracy by fine-tuning CNN layers and increasing dataset diversity.
Emotion Model Overfitting (Train: 79%, Test: 68%)	Used additional data augmentation to reduce the gap.

9. Outcomes and Impact

✅ Enhanced Security: Prevents entry of underage or elderly individuals into inappropriate screenings.
✅ Improved Audience Insights: Helps theatre management understand viewer emotions in real time.
✅ Automation & Efficiency: Reduces manual ID verification efforts.
✅ Data-Driven Decision Making: The logged data can be used for trend analysis and personalized marketing.

10. Conclusion

The Age and Emotion Detection for Movie Theatre project demonstrates how AI can enhance security, compliance, and customer experience in the entertainment industry. By leveraging deep learning, real-time face detection, and automated decision-making, this system streamlines entry control and provides valuable audience insights.

Although the emotion model (79% train, 68% test accuracy) and age model (MAE 8.1397) showed promising results, there is room for improvement in model generalization and real-time accuracy. Future improvements could include multi-person detection, faster processing, and integration with theatre ticketing systems.

This project successfully combined AI, computer vision, and automation to create a practical, real-world solution with the potential for widespread adoption in cinemas, theme parks, and security checkpoints.