**Facial Expression Recognition Documentation**

**Introduction**

Facial Expression Recognition is a computer vision task aimed at automatically detecting and categorizing human facial expressions from images or videos. This documentation presents a comprehensive overview of a Facial Expression Recognition system developed using various deep learning models and datasets.

**Dataset**

The system utilizes several datasets for training and testing:

**1. FER 2013**

The FER 2013 dataset contains grayscale images of facial expressions categorized into seven classes: anger, disgust, fear, happy, neutral, sad, and surprise.

**2. AffectNet**

AffectNet is a large-scale dataset that contains images annotated with facial expressions. For this system, a subset of AffectNet with either 2 or 8 facial expressions was used, depending on the experiment.

**Models**

Several deep learning models were employed for facial expression recognition:

**1. Convolutional Neural Network (CNN)**

A custom CNN architecture was designed for the task. This CNN model consists of multiple convolutional layers followed by max-pooling and dropout layers to extract and learn hierarchical features from facial images.

**2. MobileNet**

MobileNet is a lightweight convolutional neural network architecture optimized for mobile and embedded vision applications. In this system, MobileNet was used as a base model with additional fully connected layers for fine-tuning.

**Training and Evaluation**

The system was trained using a combination of training and validation data. The training process involved data augmentation techniques such as rotation, shifting, and flipping to improve model generalization. The performance of the models was evaluated using metrics such as accuracy.

**Experimentation and Results**

Several experiments were conducted to explore different combinations of models and datasets:

**Experiment 1:**

* Dataset: FER 2013 with seven facial expressions
* Model: Custom CNN architecture
* Training Accuracy: 68%
* Validation Accuracy: 64%

**Experiment 2:**

* Dataset: FER 2013 with three primary facial expressions
* Model: Custom CNN architecture
* Training Accuracy: 77%
* Validation Accuracy: 75%

**Experiment 3:**

* Dataset: AffectNet with happy and unhappy expressions
* Model: MobileNet architecture with additional fully connected layers
* Training Accuracy: 60%
* Validation Accuracy: 55%

**Experiment 4:**

* Dataset: AffectNet with eight facial expressions
* Model: MobileNet architecture with additional fully connected layers
* Training Accuracy: 88%
* Validation Accuracy: 78%

**Experiment 5:**

* Dataset: AffectNet with only two primary facial expressions(happy,else was considered as unhappy) and also we under sampled the targets to scale them
* Model: MobileNet architecture with additional fully connected layers
* Training Accuracy: 92%
* Validation Accuracy: 91%

**Conclusion**

Based on the experimentation and evaluation, the MobileNet architecture trained on the AffectNet dataset with two primary expressions (happy and not happy) achieved the highest accuracy and generalization performance, making it the most suitable model for integration into our game application.

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