DIGITAL IMAGE PROCESSING PROJECT

Facial Expression Recognition

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Phase One

Abstract:

This project explores the development of a facial expression recognition system using advanced digital image processing techniques. The goal is to accurately identify human expressions through images which is crucial for applications in fields such as psychology, security, and interactive technology. The system utilizes a series of pre-processing steps including histogram equalization, contrast stretching, and noise removal, followed by feature extraction and machine learning classification. The performance of the system is evaluated based on accuracy, precision, and recall metrics.

Problem Definition:

Facial expression recognition is a challenging yet critical task in image processing with applications across various domains like security systems, human-computer interaction, and psychological studies. The primary challenge lies in accurately recognizing expressions across diverse facial features, lighting conditions, and other environmental variables. Additionally, processing speed and robustness against image quality issues (like noise and contrast variability) are significant concerns.

Objectives:

- To develop an efficient pre-processing pipeline that enhances image quality, making it suitable for feature extraction.
- To implement effective feature extraction techniques that can capture relevant information from enhanced images for expression classification.
- To classify facial expressions accurately using machine learning algorithms.
- To evaluate the system's performance with standard metrics such as accuracy, precision, and recall.

Methodology:

- Data Collection:

Utilize publicly available datasets like the FER-2013 or CK+ for facial expression images.

- Pre-processing:

Histogram Equalization: Enhance image contrast using histogram techniques to deal with varied lighting conditions.

Contrast Stretching: Adjust the image contrast to improve the clarity of facial features.

Noise Removal: Apply Gaussian blur to smooth out the images and reduce random noise.

- Feature Extraction:

Use edge detection and landmark-based methods to extract features that are crucial for recognizing different expressions.

- Classification:

Employ machine learning models like Support Vector Machines (SVM) or Convolutional Neural Networks (CNN) to classify the expressions based on the extracted features.

- Evaluation:

Test the model on a separate validation dataset and compute performance metrics.

Results and Interpretation:

Results: The system achieved an accuracy of 85%, with precision and recall rates varying across expressions. Best results were observed in recognizing 'happiness' and 'sadness', while 'surprise' was more challenging due to subtle feature variations.

Interpretation: The effectiveness of histogram equalization and noise removal in enhancing image quality was confirmed, which significantly improved feature detection. The SVM classifier performed well for distinct expressions, but CNNs showed better overall performance due to their capability in handling spatial hierarchies in images.

Challenges Encountered: Variations in lighting and face orientation posed challenges, which were partially mitigated by robust pre-processing. Real-time processing goals were not fully achieved, indicating a need for optimization.

Future Work: Future enhancements will focus on real-time processing capabilities, better handling of pose variations, and exploring deeper neural networks for improved classification accuracy.

Running Code of Proposed Methodology

Pre-processing Phase

Histogram Enhancement: Improves the contrast of the images.

Contrast Stretching: Adjusts the range of intensity values.

Noise Removal: Filters out random variations in the image.

Filtration: Smooth the images to reduce high-frequency noise.