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Facial Recognition under Varying Lighting Conditions using Support Vector Machine

영상이해 001분반 / Understanding of Images

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1 Project Summary

The project focuses on solving the challenges associated with facial recognition when the lighting conditions vary significantly. Lighting variations are one of the key factors that degrade the performance of facial recognition systems, making it difficult for traditional algorithms to accurately identify faces. To address this, the project will utilize Support Vector Machines (SVM), which are known for their robustness in handling classification problems with high-dimensional data.

The primary goal of the project is to enhance the accuracy of facial recognition systems by training an SVM model to distinguish between faces, even when lighting conditions change. The Yale Face Dataset B, which is specifically designed for testing facial recognition under various lighting environments, will be used for this purpose. This dataset provides a comprehensive set of facial images taken under different controlled lighting conditions, offering a robust testbed for evaluating the performance of the SVM model.

The SVM will be trained to classify facial features and predict identities based on patterns found in the dataset. One of the major advantages of using SVM in this scenario is its ability to find an optimal decision boundary between different classes, in this context different faces, and its effectiveness in avoiding overfitting, which is particularly useful for small-to-medium sized datasets like the Yale Face Dataset B.

By the end of this project, the goal is to demonstrate that SVM can significantly improve the performance of facial recognition systems under challenging lighting conditions, making them more reliable and accurate in real-world applications.

2 Background and Motivation

Facial recognition has become one of the most significant technological advancements, especially in the context of security, crime prevention, and authentication processes. This technology is extensively used in public places such as train stations, airports, and large events to identify and track individuals, helping to reduce criminal activity. Moreover, facial recognition is a vital tool for biometric authentication in our daily lives, such as unlocking smartphones, securing financial transactions, and controlling access to restricted areas. Beyond security, the technology also finds applications in healthcare, where it can help detect mental illnesses, diagnose certain medical conditions, or even monitor patients' emotions.

Given its broad range of applications, facial recognition systems must perform reliably across various environments. One of the key challenges in ensuring their effectiveness is the ability to cope with lighting variations. Changes in lighting can

lead to shadows, overexposed or underexposed images, and general inconsistencies in visibility, all of which impact the system's ability to recognize a face. These changes can obscure or distort the facial features that the system relies on to make accurate identifications. As lighting conditions are one of the most common and unavoidable environmental variables, it is crucial to develop systems that can handle such variations effectively.

This project is motivated by the need for more robust facial recognition systems that can function accurately under varying lighting conditions. By improving a system's ability to overcome these challenges, it can become more reliable and versatile, enhancing its performance in real-world applications.

3 Technical Approach

This project focuses on developing a classification methodology using an SVM-based algorithm to recognize facial images under varying lighting conditions. SVMs were selected due to their strength in handling high-dimensional feature spaces, which is essential for image-based tasks where each pixel serves as a feature. Furthermore, SVMs excel at managing non-linear data separability by employing kernel functions, allowing them to form complex decision boundaries. This adaptability is particularly important for compensating for the variations in facial features caused by changes in lighting.

The technology stack for this project includes Python as the primary programming language, complemented by essential libraries such as Scikit-learn for building machine learning models, OpenCV for image processing, and NumPy for numerical computations. The dataset used for training and evaluation will be the Extended Yale Face Database B, which offers a wide variety of facial images captured under different lighting angles and intensities. This makes it an ideal choice for the project's aim of improving facial recognition accuracy under challenging lighting conditions. Additionally, the dataset is of a manageable size, which fits well with the computational efficiency of SVM algorithms.

References

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