CPSC 5610-02, Fall 2023
Assignment: PROJECT MILESTONE 2
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Pledge: "I have not received unauthorized aid on this assignment. I understand the answers that I have submitted. The answers submitted have not been directly copied from another source, but instead, are written in my own words."

INTRODUCTION:

Emotion recognition is vital for human-computer interaction (HCI) and user experience. Deciphering emotional states using facial expressions has diverse applications in leisure, commerce, education, and psychological well-being. Artificial intelligence, particularly neural networks, has evolved to model facial recognition for emotionally sensitive HCI systems. However, integration of emotional states into HCI systems remains limited, resulting in a loss of crucial information during user interaction.

Emotion recognition technologies use images, speech, and biosignals to evaluate a person's emotional state. Researchers are developing more robust detection methods to improve accuracy by addressing occlusion caused by accessories. Researchers propose an emotion detection system using Bayesian networks that consider partial face occlusion. This novel system focuses on causal relationships between facial features, enabling robots to perceive and respond appropriately to human emotions for smoother and more intuitive human-robot interactions.

Methodologies

The combined methodologies encompass various aspects focusing on facial emotion detection and recognition. One approach involves the utilization of Convolutional Neural Networks (CNNs), showcasing models A and B, employing intricate architectures through the Keras library. Both models utilize CNN layers, local contrast normalization, and specific activation functions for emotion classification. Model A emphasizes feature extraction from facial components, while Model B adopts a simpler architecture.

Second methodology centers on facial component detection, comprising multi-step processes for face detection and subsequent identification of specific components like eyes, nose, and lips. These techniques leverage color models, skin color segmentation, morphological operations, and feature extraction to precisely locate facial regions and components within them, vital for accurate emotion interpretation.

Another methodology is the Bayesian Network for Emotion Recognition. It focuses on the significance of emotions in human communication and proposes an emotion detection system for robots. The method identifies universal emotions and their relationship with facial expressions based on Paul Ekman's work. It utilizes Bayesian networks as classifiers for emotion detection, taking into account the causal relations among facial features and emotions. Experiments using a Japanese Female Facial Expression (JAFFE) database show promising results in emotion detection, especially in scenarios with partially occluded facial features.

These methodologies underscore the importance of emotions in human communication and the strong correlation between emotions and facial expressions. Facial expressions are utilized as indicators of human emotions, with predefined facial feature motions considered as variables for emotion detection.

The research methodologies aim at advancing emotion recognition by accurately detecting and interpreting facial expressions. An emphasis on the significance of facial components in understanding emotions underlies the foundation of this work. Accurate identification of facial components, like eyes, nose, and lips, serves as a pivotal element for interpreting facial expressions—a cornerstone of emotion recognition.

This research employs diverse approaches to enhance emotion recognition. It utilizes datasets displaying seven emotions, training deep convolutional neural networks on GPUs for 100 epochs. The resultant models exhibit increased accuracy, reduced computation time, and enhanced validation accuracy in detecting emotions.

The precise localization of facial components, such as eyes, nose, and lips, forms the basis for interpreting facial expressions representative of various emotions. The methodologies employed include advanced techniques like skin color segmentation, morphological operations, and maximum morphological gradient methods for more precise face detection. Additionally, they systematically detect facial components within limited candidate regions using geometric information, thus enhancing accuracy.

The study's **significance** lies in its contribution to understanding emotions through accurate facial expression analysis. Notably, the emphasis on causal relations among facial features in a Bayesian network classifier significantly improves emotion detection accuracy, overcoming limitations observed in conventional methods. Importantly, this research demonstrates improved robustness against facial occlusion, indicating its effectiveness in recognizing emotions accurately.

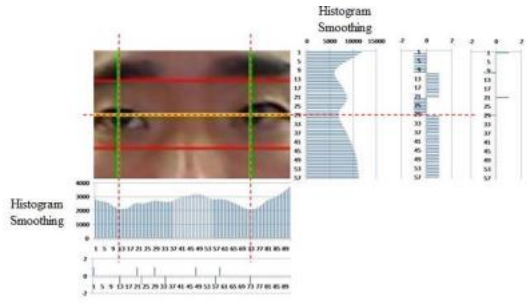
CONCLUSION

The proposed facial emotion detection model utilizes Bayesian networks to recognize emotions even when the face is partially covered. The model was developed using two different datasets, namely JAFFE and FERC-2013. To evaluate the performance of the model, several metrics were considered, including validation accuracy, computational complexity, detection rate, learning rate, validation loss, and computational time per step. The proposed model was analyzed using trained and test sample images, and its performance was compared to previously existing models. The results of extensive experiments showed that the proposed model outperformed traditional methods and achieved recognition rates of over 50% with minimal errors, even when facial features were partially occluded.

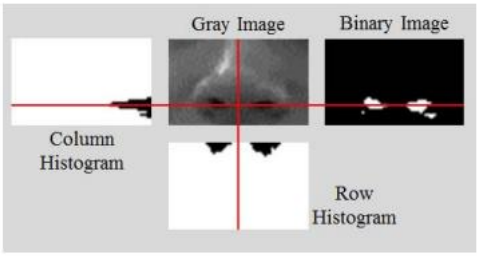
The study focused on developing a method that establishes strong relationships between facial features and emotions, with a particular emphasis on happiness and surprise. The approach used K2 to learn the structure among facial features. The relationships among facial features were researched in the field of anatomy, and the researchers aim to reform relationships learned by K2 based on anatomical research and establish real causal relations.

Future research directions involve refining facial feature relationships based on anatomical research to further enhance recognition rates. Additionally, the researchers aim to integrate the emotion detection system into communication robots and assess their effectiveness in facilitating human-robot interaction. In summary, this study presents an innovative approach to detecting emotions and demonstrates the effectiveness of Bayesian networks in recognizing emotions despite partial facial occlusion.

Reference Picture:

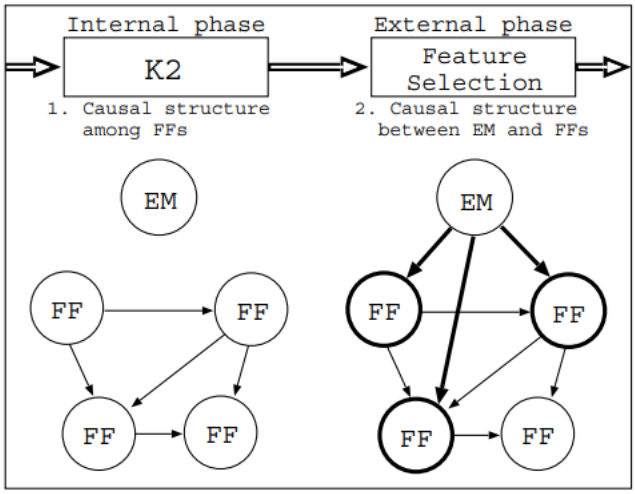


Pupil position detection using histogram analysis



Nose position detection using histogram analysis

Detected lip region



Process flow of learning the structure of the Bayesian network