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Credit Hours System
CMPS446
IP & CV

Image Processing & Computer Vision

Project Proposal

Hand Gestures

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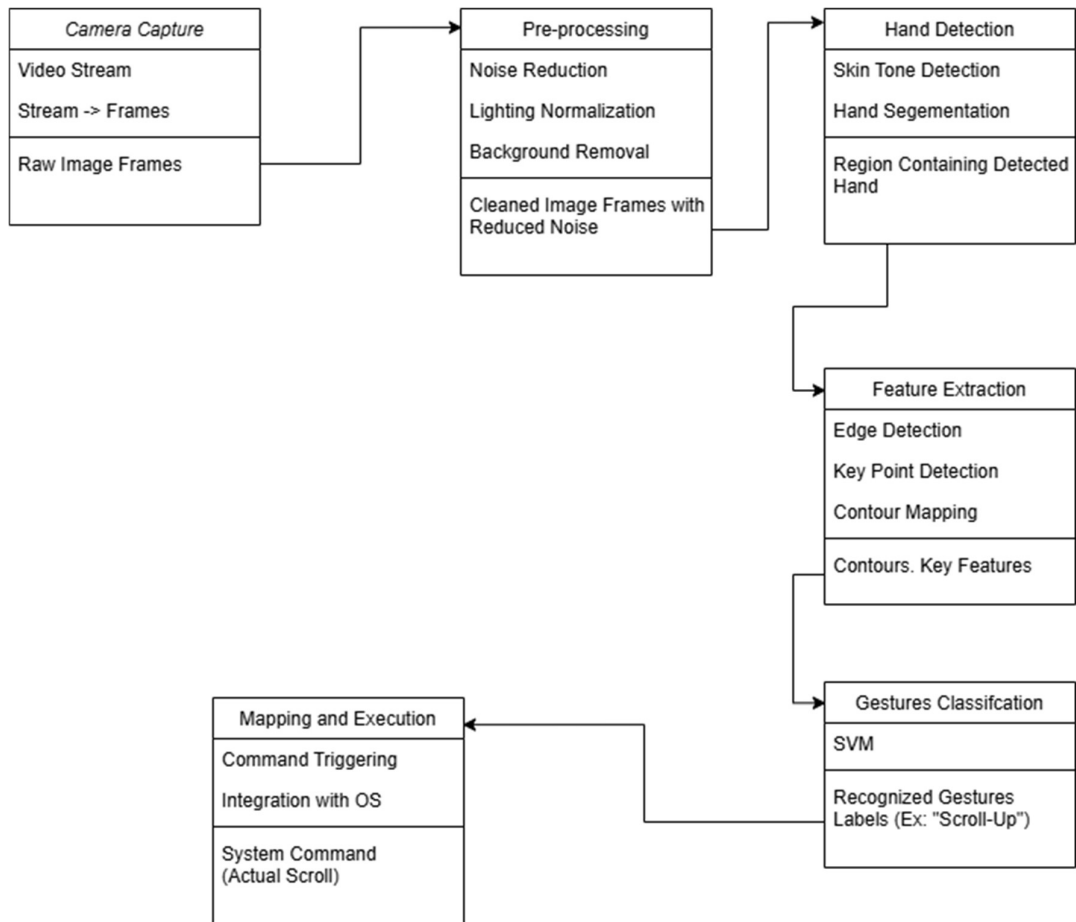
Project Idea and Need

The project aims to create a robust hand gesture recognition system that enables touch-free interaction with digital interfaces. This is especially beneficial in applications where direct physical contact may not be feasible or safe, such as in healthcare, public spaces, or industrial environments. The system will recognize five specific gestures to control basic navigation functions: scrolling up and down, closing the current page, and zooming in or out. By leveraging computer vision and machine learning, this system offers an intuitive alternative to conventional input devices, enhancing accessibility and user experience.

Features

1. **Scroll Up:** A gesture where the hand moves upward, signaling the system to scroll content up.
 2. **Scroll Down:** A gesture where the hand moves downward, indicating the system to scroll content down.
 3. **Close Current Page:** A gesture where the hand forms a fist and moves horizontally across the body, prompting the system to close the current page or application.
 4. **Zoom In:** A gesture where the fingers spread apart, signaling the system to zoom in on content.
 5. **Zoom Out:** A gesture where the fingers pinch together, instructing the system to zoom out.
- **Gesture Recognition:** Detects five unique hand gestures with high accuracy, ensuring reliable interaction.
 - **Lighting Adaptability:** Optimized to handle different lighting conditions, from low light to bright light, ensuring consistent performance across diverse environments.
 - **Angle Robustness:** Capable of recognizing gestures from various viewing angles, allowing for more natural user interaction.
 - **Real-Time Processing:** Processes video streams in real time, providing immediate feedback for dynamic applications.
 - **Scalability:** Easily scalable to add more gestures or adapt to different hand shapes and sizes.
 - **Noise Handling:** Includes filtering and pre-processing to reduce the impact of background noise and occlusions.

Informative Block Diagram



Hand Gesture Recognition System

i. Inputs:

- **Video Stream:** Live video feed from a camera (input for real-time gesture processing)
- **Lighting Data:** Environmental lighting conditions (used to adjust processing techniques for accurate gesture recognition)
- **View Angle:** Camera angle in relation to hand (used to adjust for different perspectives)

ii. Blocks:

1. Pre-processing

- **Function:** Adjust for lighting, normalize image size, and filter out background noise.
- **Methods:** Grayscale conversion, contrast adjustment, background subtraction.

2. Hand Detection and Segmentation

- **Function:** Identify the hand in the frame and separate it from the background.
- **Methods:** Skin color segmentation, contour detection, and bounding box extraction.

3. Feature Extraction

- **Function:** Extract specific features of the hand shape and position, such as finger position, orientation, and hand movement.
- **Methods:** Key point detection, HOG, edge detection, and shape descriptors.

4. Gesture Classification

- **Function:** Classify the gesture based on the extracted features.
- **Methods:** Machine learning model (e.g., SVM KNN) trained to recognize five gestures.

5. Command Execution

- **Function:** Trigger the appropriate action based on the recognized gesture.

iii. Outputs:

- **Scroll Up:** Move content up on the display.
- **Scroll Down:** Move content down.
- **Close Page:** Close the active page or application.
- **Zoom In:** Enlarge the content.
- **Zoom Out:** Shrink the content.

Non-Primitive Functions Needed

Gesture Classification Model:

Support Vector Machines (SVMs) to classify gestures based on features extracted from different algorithms. This model will likely need to be implemented from scratch.

Hand Detection and Segmentation:

Custom functions for **segmenting** the hand from the background, possibly using contour-based methods or a lightweight object detection model.

Feature Extraction Function:

Algorithms to detect and extract specific hand shape features, such as finger positions and hand orientation, which will be implemented for precise recognition.

Additional Comments

To make the system highly responsive, optimized algorithms for real-time video processing will be crucial. Considerations should also be given to handling different skin tones, background complexities, and occlusions. To achieve robustness under different lighting conditions, adaptive histogram equalization or other normalization techniques may be applied.

Scientific References

1. ***Kim, W., & Hwang, J.* (2019).** Real-time hand gesture recognition for touchless healthcare system. IEEE Access, 7, 99674-99683. This paper covers methods for real-time hand gesture recognition in healthcare applications, relevant for processing under varied lighting and viewing conditions.

2. ***Shah, S., & Banerjee, S.* (2018).** A study on hand gesture recognition in augmented reality using computer vision. International Journal of Computer Vision & Signal Processing, 8(2), 45-55. Discusses gesture recognition models and strategies for achieving high accuracy in varied lighting.

3. ***Huang, D., & Han, Z.* (2021).** Multi-view hand gesture recognition in uncontrolled environments. Pattern Recognition, 118, 108047. Provides insight into handling different viewing angles and complex backgrounds.