Hand Gesture Recognition Using Haar-Like Features & SCFG

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CSE424 [Task- 02]

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Introduction

- Text-based to VE systems: Progression of interfaces
- **Hand gestures in VEs:** Powerful communication modality
- Challenges with traditional glove-based devices
- **Vision-based recognition:** Real-time solutions
- **Categories:** Appearance-based and 3-D model-based approaches
- **Trade-offs:** Real-time performance vs. computational complexities
- **Current challenges:** Lack of speed and accuracy in recognition
- **Need for innovative solutions:** Robust an accessible hand tracking in real-time applications

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Two level Approach

Two level Approach

- **Definitions:**
  ** Static Hand Posture & Dynamic hand gesture sequence
- **Dynamic Aspect:**
  ** Global and local motions & Gesture as a composite action
- **Recognition Problem:**
  ** **Two levels:** Detection and analysis
- **Image Features:**
  ** Skin color and hand shape with challenges of Object distinction, lighting, computational cost
- **Statistical Approach:**
  ** Haar-like features
  ** AdaBoost for accuracy and real-time performance
- **Syntactic Object Description:**
  ** Overcomes quantitative limitations
  ** Grammar-based for hierarchical representation

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Posture Detection using Haar-like feature

Posture Detection Using Haar-Like Features

- **Background:**
  ** Statistical approach with "integral image" and Haar-like features
- **Features and Integral Image:**
  ** Efficiently encoding domain knowledge with Enhanced speed compared to raw pixels
  ** Describe dark-bright area ratios within a kernel while Computing pixel sums efficiently
  ** Achieves true scale invariance, reducing need for multiscale pyramids
- **AdaBoost Algorithm:**
  ** Used for feature selection and also boosts accuracy while maintaining high speed
- **Adaptation for Hand Gestures:**
  ** Tested with four postures using cascade classifiers
  ** Achieved high accuracy (97-98%) for various hand gestures
- **Robustness and Real-time Recognition:**
  ** Robust against lighting variations
  ** Background subtraction for cluttered backgrounds
  ** Achieved real-time recognition with minimal latency

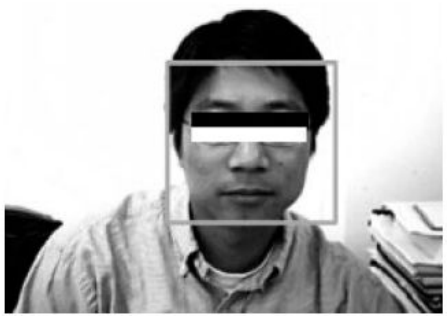

Fig. 3. Detecting a face with a subwindow containing a Haar-like feature.

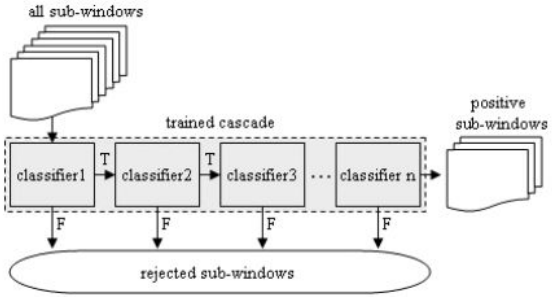

Fig. 5. Detection of positive subwindows using the trained cascade.

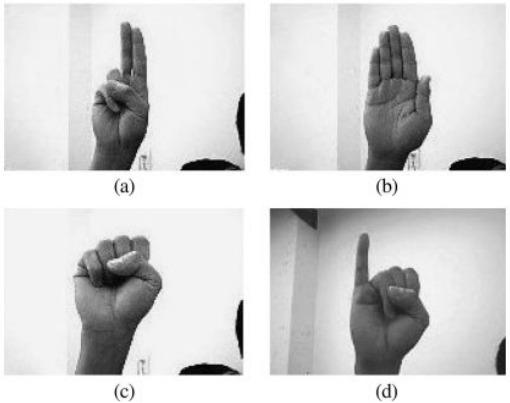

Fig. 6. Gestures tested with the Viola and Jones algorithm.

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Gesture Recognition using an SCFG

Gesture Recognition using an SCFG

- **Gesture Representation:**
  ** Sequences of connected hand postures.
  ** SCFG for hierarchical gesture structure.
- **SCFG Overview:**
  ** SCFG: Four-tuple structure (VN, VT, PS, S) while using previous SCFG applications in activity recognition.
- **SCFG vs. HMMs:**
  ** SCFG's flexibility compared to HMMs. Also SCFG is suitable for diverse gesture modeling.
- **Implementation:**
  ** SCFG for hand gesture representation with three gestures generated: "Grasp," "Quote," "J."
- **Probability-Driven Recognition:**
  ** Assigning probabilities to production rules.
  ** Controls recognition, reduces "unwanted" gestures.
- **Flexibility and Extensibility:**
  ** SCFG's flexibility for diverse gestures and has potential extension for complex gestures.

Gesture Recognition using an SCFG

Fig. 8. Part of the negative samples used in the training process.

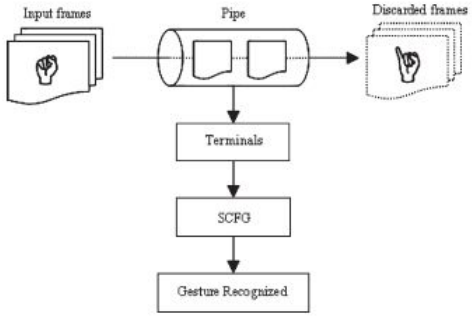

Fig. 14. Pipe structure to convert postures into terminal strings.

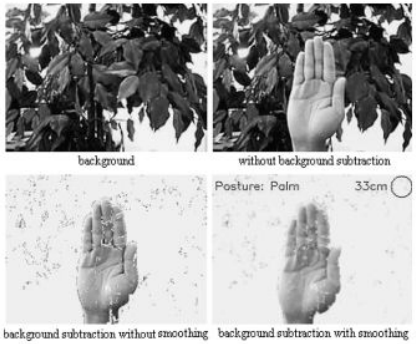

Fig. 10. Effects of background subtraction and smoothing.

Fig. 9. Detection result of the trained "two fingers" cascade classifier.

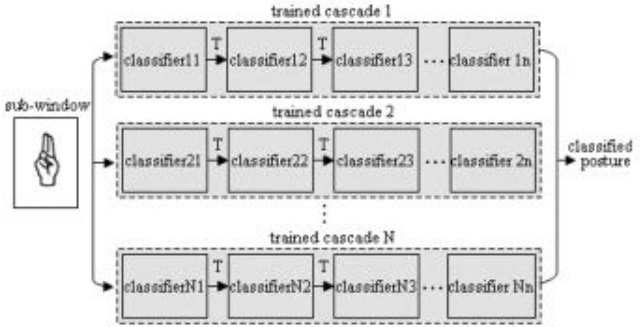

Fig. 11. Parallel cascade architecture for hand posture recognition.

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Conclusion

Conclusion

- **Two-Level Approach:**
  ** Low: Haar-like features + AdaBoost.
  ** High: SCFG for syntactic analysis.
- **Low-Level:**
  ** Effective Haar-like features with AdaBoost for strong classifier.
- **Parallel Cascade:**
  ** Trained classifiers for real-time recognition along with high accuracy and speed.
- **High-Level SCFG:**
  ** Converts postures to strings.
  ** Identifies gestures with probabilities.
- **Contributions:**
  ** Real-time accuracy & flexible gesture control.
- **System Validation:**
  ** Successful real-time recognition..

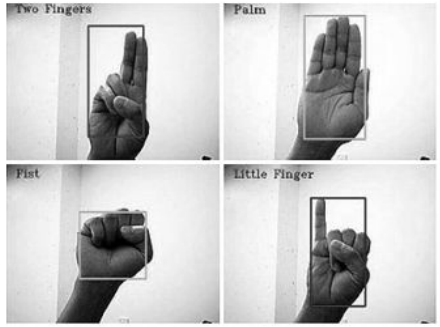

Fig. 12. Recognition results with the parallel cascade architecture.

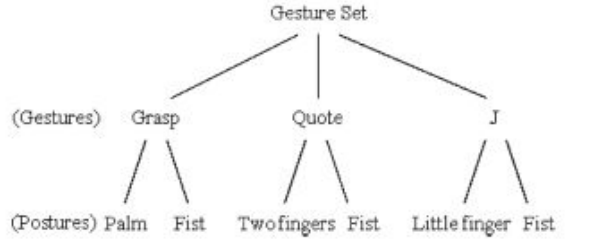

Fig. 13. Gestures that are generated with different postures.

Thank You