Network Enabled Feature Search for High Speed Face Recognition in Video Sequences

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Thesis Statement

• Number, location, size and orientation of human faces vary from frame to frame
• Multiple training images in various poses and illumination may not be available
• Feature-based face recognition should be independent of pose and lighting
• A detected face should be recognized based on databases around the world
Research in a Nutshell

- Face regions are detected from images captured by three surveillance cameras
- A multidimensional feature matrix representing multiple views is created
- Worldwide search from databases distributed on different servers
- Images in low lighting conditions are brightened by lighting compensation
Image Enhancement

- Each pixel in the RGB space is enhanced by a nonlinear process
Face Detection

- Skin region extraction by a multilevel hill-clustering approach in r-g-b space
- Statistical features from wavelets to represent textures of skin-regions
- Classification of skin-regions to face and non-face classes
Feature Extraction

• Reconstruct faces for all poses and illuminations using Tensorface approach
• A modular form of principal component analysis on each of eight face groups
Feature Search

- Router sends feature matrix generated by image processor to active router
- Active middleware sends the processed streams to distributed servers
Active Router

- Active router includes active middleware and high-speed hardware components
Active Middleware

- The middleware initiates the connections on-demand between the servers
- Real-time requests are given highest priority in local and network processing
Virtual Private Network

- Feature matrices are distributed using reliable end-system multicasting
- All communications are secured using Virtual Private Network (VPN)
- VPNs are created in a way optimizing the response time and network size
- A wide area network test-bed is built over the existing Internet infrastructure
• Test-bed includes VLSI Systems Lab, Networking Research Lab, and Nanyang Technological University at Singapore
Face Recognition System

- VLSI design of the face recognition system for real time performance
- Feature extraction, switching, feature search and face recognition in 150 ms
- Collaboration with the Center for High Performance Embedded Systems at Nanyang Technological University, Singapore for IC design and fabrication
Benefit to Defense and Homeland Security

- Individuals could be identified from data distributed around the world
- Face feature matrix includes effects of different orientation, pose, and lighting
- Search at multiple servers situated in multiple regions, agencies and offices
- Robustly recognize faces, even with only one training image of an individual
- A universal solution to secure the homeland from intruders by providing a transparent environment
Research Sponsors

- Department of Defense
  (Technology Support Working Group)
  *Project Title*: Pose and Lighting Invariant Face Detection Algorithm

- Seacom
  *Project Title*: VLSI Implementation of a Multilevel Neural Network Based Face Recognition System

- ODU Research Foundation
  *Project Title*: Development of an Adaptive Technique for the Extraction of Object Region and Boundary from Images with Complex Background Environment
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