A Review of Human Feature Detection Techniques

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Outline

Introduction

Applications to Categorize Body Shapes

Systems which Extract Body Features

Methods for Identifying Humans

Discussion of Findings

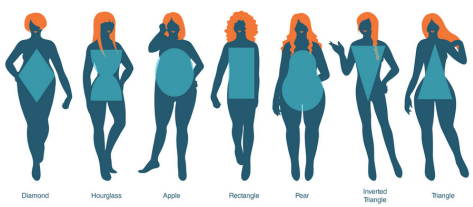
Future Plans

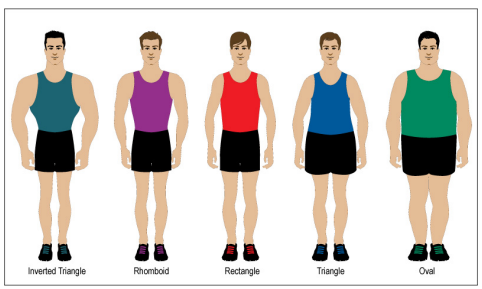
Introduction

- Applications of human/body shape detection:
  - Medical analysis, health care
  - Entertainment eg. games
  - Surveillance
  - Pedestrian detection
  - Driving assistance system
  - Gesture recognition
  - Content-based image retrieval
  - Clothing industry
- Challenges of human/body shape detection:
  - Varying appearance (skin colour, height, etc.)
  - Varying poses
  - Differences in clothing
  - Varying background
  - Cluttered Background
  - Shadows
  - Illumination
  - Occlusion

Introduction Cont'd

- Body Shape analysis can be used to determine a person's health.
- Wang et al. (2015) [1]:
  - Fat distribution (and therefore body shape) can determine a person's chances of developing cardiovascular diseases and other related diseases.





Applications to Categorize Body Shapes

- Mainly used for Online Fashion/Virtual Fitting
- Simmons, Istook and Devarajan (2004) [2]
  - 3D body scan data (includes measurement data)
  - Mathematical logic for body shapes
  - 9 shapes: hourglass, oval, triangle, inverted triangle, rectangle, spoon, diamond, bottom hourglass, top hourglass
  - Tested with 222 subject measurements
  - Most subjects were accurately categorized

Applications to Categorize Body Shapes Cont'd

- Neophytou et al. (2013) [3]
  - Background extraction: A GrabCut method (Rother et al. 2004)
  - Principal component analysis applied to vertex coordinates from example scans of models in a standard pose
  - Calculations from Simmons, Istook and Devarajan (2004)
  - Body dimension accuracy error: average $<$3cm
  - 8 out of 10 subjects classified accurately

Applications to Categorize Body Shapes Cont'd

- Sekine et al. (2014) [4]
  - Depth images
  - System underwent pre-training
  - Pre-trained images used to determine body shape of user
  - Energy function was used to optimize the selected model
- Kart et al. (2011) [5]
  - User inputted data: height, weight, age, region and 2D photograph
  - Pixel numbers used to estimate body dimensions
  - MATLAB Image Processing Toolbox
  - Decision algorithm

Systems which Extract Body Features

- Lee and Nevatia (2007) [6]
  - Foreground blobs (ellipses) are extracted from background
  - Hierarchical approach for determining body parts: start at head, move downwards
    - Likelihood function based on Chamfer distance
    - AdaBoost for face detection
    - Colour Histograms for skin and hair
  - Edges extracted using Canny detector
  - Data-driven Markov chain Monte Carlo (DD-MCMC): pose estimation
  - Average error: 9.86 pixels

Systems which Extract Body Features Cont'd

- Shotton et al. (2013) [7]
  - Depth images from the Kinect
  - Aim: Output 3D skeletons of users
  - Per-pixel classification for segmentation of body parts
  - Randomized decision forests - trained with synthetic depth images
  - System was highly accurate for both synthetic and real test sets

Systems which Extract Body Features Cont'd

- Brandao, Fernandes and Clua (2014) [8]
  - Combined analysis of both depth and color images
  - Used a combination of techniques:
    - Background Extraction
    - Body Part Detection: Euclidean distance, Accumulative Geodesic Extrema Points (AGEX), Affine Scale-Invariant Feature Transform (ASIFT)
    - Pose Classifiers: Gain Ratio Decision Tree, Naive Bayes, K - Nearest Neighbours (KNN)
  - Method works well with indoor conditions, static background and no-self occlusions

Methods for Identifying Humans

- Dalal and Triggs (2005) [9]
  - Histogram of Oriented Gradients (HOG)
  - Popular method for human detection
  - Uses local intensity gradients and edge directions
  - Detection window is tiled with overlapping grids of HOG descriptors
  - SVM used to classify grids into human/non-human
  - Perfect results with MIT pedestrian database
  - Created INRIA: a more complex database

Methods for Identifying Humans Cont'd

- Ubukata et al. (2014) [10]
  - Stereo camera
  - Subtraction Stereo
  - Mean Shift Clustering
  - HOG
  - NICTA Pedestrian Dataset
  - 11fps, online detection
- Lee et al. (2010) [11]
  - HOG with human body ratio estimation
  - Video
  - DaimlerChrysler pedestrian datasets
  - SVM
  - Worked well with little occlusion

Methods for Identifying Humans Cont'd

- Li, Guo and Hu (2010) [12]
  - Videos, detection and tracking
  - HOG
  - Kalman filter - predictions improve detection and tracking
  - Faster and more accurate than using HOG only
- Wang, Gong, Liu (2008) [13]
  - Learned Multi-scale Mid-level Features (LMMF)
  - Guassian Pyramids
  - REDUCE operator
  - AdaBoost
  - INRIA dataset
  - Low miss rates

Methods for Identifying Humans Cont'd

- Han et al. (2010) [14]
  - Curvelet Tranform
  - Edge features and texture features
  - AdaBoost
  - INRIA dataset
  - Faster than HOG with SVM
- Kim et al. (2012) [15]
  - Wavelet-based center symmetric local binary pattern (WCS-LBP)
  - Random Forests
  - INRIA dataset
  - Faster and more accurate than previous HOG and LBP approaches

Discussion of Findings

- Human detection and feature extraction is still a challenging task
- Not much work has been done on body shape classification
  - Classification based on body part measurements
- Human detection process involves (depending on implementation):
  - Background extraction
  - Sliding windows approach
  - Image segmentation
  - Classification
    - Classifiers: SVM, AdaBoost, Randomized decision forests
    - Trained with large datasets
  - Testing and Comparison

Future Plans

- Monitor body shape of secondary school students.
- On monthly basis, capture frontal and profile photos.
- Pre-processing on client side.
- Futher processing performed by a central server.
- Historical data can be used to determine trends.
- Alert school's administration of potential health risks.

References

[1] S. Wang, Y. Liu, F. Li, H. Jia, L. Liu, and F. Xue, "A novel quantitative body shape score for detecting association between obesity and hypertension in china," *BMC Public Health*, vol. 15, no. 7, 2015.

[2] K. Simmons, C. L. Istook, and P. Devarajan, "Female figure identification technique (ffit) for apparel part i: Describing female shapes," *Journal Of Textile And Apparel Technology And Management*, vol. 4, no. 1, 2004.

[3] A. Neophytou, Q. Yu, A. Hilton, and P. Delamore, "3d human body shape estimation and classification for online fashion," in *Digital Fashion 2013*, May 2013.

[4] M. Sekine, K. Sugita, F. Perbet, and M. N. Bjorn Stenger, "Virtual fitting by single-shot body shape estimation," in *3D Body Scanning Technologies, Proceedings of 5th International Conference on*, 2014, pp. 406–413.

[5] O. Kart, A. Kut, A. Vuruskan, and E. Bulgun, "Web based digital image processing tool for body shape detection," in *ICT Innovations, 2011 Web Proceedings*, Sep 2011, pp. 139–147.

[6] M. W. Lee and R. Nevatia, "Body part detection for human pose estimation and tracking," in *Motion and Video Computing, 2007. WMVC '07. IEEE Workshop on*, Feb 2007, pp. 23–23.

[7] J. Shotton, T. Sharp, A. Kipman, A. Fitzgibbon, M. Finocchio, A. Blake, M. Cook, and R. Moore, "Real-time human pose recognition in parts from single depth images," *Commun. ACM*, vol. 56, no. 1, pp. 116–124, Jan. 2013. [Online]. Available: http://doi.acm.org.ezproxy.sastudents.uwi.tt:2048/10.1145/2398356.2398381

[8] A. Brandao, L. A. F. Fernandes, and E. Clua, "M5aie - a method for body part detection and tracking using rgb-d images," in *Computer Vision Theory and Applications (VISAPP), 2014 International Conference on*, Jan 2014, pp. 367–377.

[9] N. Dalal and B. Triggs, "Histograms of oriented gradients for human detection," in *Computer Vision and Pattern Recognition, 2005. CVPR 2005. IEEE Computer Society Conference on*, vol. 1, June 2005, pp. 886–893 vol. 1.

[10] T. Ubukata, M. Shibata, K. Terabayashi, A. Mora, T. Kawashita, G. Masuyama, and K. Umeda, "Fast human detection combining range image segmentation and local feature based detection," in *Pattern Recognition (ICPR), 2014 22nd International Conference on*, Aug 2014, pp. 4281–4286.

[11] K. Lee, C. Y. Choo, H. Q. See, Z. J. Tan, and Y. Lee, "Human detection using histogram of oriented gradients and human body ratio estimation," in *Computer Science and Information Technology (ICCSIT), 2010 3rd IEEE International Conference on*, vol. 4, July 2010, pp. 18–22.

[12] C. Li, L. Guo, and Y. Hu, "A new method combining hog and kalman filter for video-based human detection and tracking," in *Image and Signal Processing (CISP), 2010 3rd International Congress on*, vol. 1, Oct 2010, pp. 290–293.

[13] T. Wang, L. Gong, and F. Liu, "Detecting human in still images by learning multi-scale mid-level features," in *Innovative Computing Information and Control, 2008. ICICIC '08. 3rd International Conference on*, June 2008, pp. 361–361.

[14] H. Han, Y. Fan, L. Jiao, and Z. Chen, "Concatenated edge and co-occurrence feature extracted from curvelet transform for human detection," in *Image and Vision Computing New Zealand (IVCNZ), 2010 25th International Conference of*, Nov 2010, pp. 1–8.

[15] D.-Y. Kim, J.-Y. Kwak, B. Ko, and J.-Y. Nam, "Human detection using wavelet-based cs-lbp and a cascade of random forests," in *Multimedia and Expo (ICME), 2012 IEEE International Conference on*, July 2012, pp. 362–367.

Questions?