Approach to extracting the human body framework from a color image

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Abstract

Extracting human body (HB) framework from images.

The considered HB-image strictly follows the fundamental assumption: only one front-viewed standing human body dressing clothes with long sleeves and long trousers.

Three main steps devised in our approach to extract the human body framework are face detection, segmentation of clothes and trousers regions, and positioning all human body parts.
Introduction

In the past ten years, to enhance the human-computer interaction (HCI), many researches of computer vision have been conducted in the field of gesture recognition [1, 2], face recognition [3, 4], and expression recognition [5, 6]. Recently, some research results from these have been moved into commercial products one after another, e.g., the Magic Board [7] and the person identification [8].
Introduction

The research topic of “looking at people,” which gives computer the ability to detect, track, identify people, and further interpret human behavior, has become a central topic in computer vision field [9, 10].

Four classes based on the type of sources are static 2D image, static 3D image, dynamic 2D image frames, and dynamic 3D image frames.
Introduction

If only a static single image (This is a real case since the photograph is often used in our daily life) is adopted, the posture extraction will become difficult due to the lack of temporal information compared with a sequence of image frames. Furthermore, it is also worthy of exploring the image processing techniques used to analyze the static human body image. Accordingly, the goal of this paper is to present our recent research on the extraction of human body framework from a color image.
Framework of a Human Body

left shoulder joint
left upper arm
left elbow joint
left wrist
left forearm
left hip joint
left thigh
left knee joint
left shin
left ankle
right shoulder joint
right upper arm
right elbow joint
right wrist
right forearm
right hip joint
right thigh
right knee joint
right shin
right ankle
Framework of a Human Body

\( V_s^l = (x_s^l, y_s^l; L_s^l, \theta_s^l) \)
\( V_e^l = (x_e^l, y_e^l; L_e^l, \theta_e^l) \)
\( V_w^l = (x_w^l, y_w^l) \)
\( (x_H^l, y_H^u) \)
\( V_h^l = (x_h^l, y_h^l; L_h^l, \theta_h^l) \)
\( V_k^l = (x_k^l, y_k^l; L_k^l, \theta_k^l) \)
\( V_a^l = (x_a^l, y_a^l) \)
\( V_s^r = (x_s^r, y_s^r; L_s^r, \theta_s^r) \)
\( V_e^r = (x_e^r, y_e^r; L_e^r, \theta_e^r) \)
\( V_w^r = (x_w^r, y_w^r) \)
\( (x_H^r, y_H^d) \)
\( V_h^r = (x_h^r, y_h^r; L_h^r, \theta_h^r) \)
\( V_k^r = (x_k^r, y_k^r; L_k^r, \theta_k^r) \)
\( V_a^r = (x_a^r, y_a^r) \)
Proposed Approach

Three main steps are developed in this paper to extract the HB-framework. They are

(1) face detection (see Section 3),

(2) segmentation of clothes and trousers regions (see Section 4), and

(3) positioning of all human body parts for accomplishing HB-framework extraction.
Face Detection
Face Detection
Face Detection
Face Detection
Face Detection
SEGMENTATION OF CLOTHES AND TROUSERS REGIONS
SEGMENTATION OF CLOTHES AND TROUSERS REGIONS

p.d.f of the initial seed block image

cluster 1

cluster 2

cluster 3
SEGMENTATION OF CLOTHES AND TROUSERS REGIONS

Since we cannot exactly state that the texture features of contain enough information, it is reasonable to increase the block size until the texture features are stable. Next, to confirm the little variation of texture features involved in the selected block, it is also suitable to decrease the block size until the texture features are out-of-stable. The block size before instability of texture features occurs is just the size of the final seed block.
SEGMENTATION OF CLOTHES AND TROUSERS REGIONS
SEGMENTATION OF CLOTHES AND TROUSERS REGIONS
SEGMENTATION OF CLOTHES AND TROUSERS REGIONS

The found similarity information of texture features illustrates two facts: (1) the desired region is connected, and (2) there are many folds or shadows, in particular, appearing at the boundary of the region.

These facts are useful to position the parts of a HB-framework by means of exploring the similarity homogeneous and inhomogeneous properties in a local area.
SEGMENTATION OF CLOTHES AND TROUSERS REGIONS

$I_{\text{clothes}}^{HI}$  

$I_{\text{trousers}}^{HI}$
SEGMENTATION OF CLOTHES AND TROUSERS REGIONS

I_{IHI}^{clothes}
SEGMENTATION OF CLOTHES AND TROUSERS REGIONS
SEGMENTATION OF CLOTHES AND TROUSERS REGIONS

![Image showing segmented clothes and trousers regions with graphs representing right arm, left arm, and right arm distances as a function of angle.](image-url)
SEGMENTATION OF CLOTHES AND TROUSERS REGIONS

- Right Arm
- Left Arm
- Right Arm

Distance vs. Angle Graph:
- X-axis: Angle (0 to 400)
- Y-axis: Distance (0 to 60)
- Graph shows two peaks corresponding to the left and right arm regions.
SEGMENTATION OF CLOTHES AND TROUSERS REGIONS

\[
(x^l_h, y^u_h; x^r_h, y^d_h) = (210,103;310,268)
\]
\[
(x^l_s, y^l_s; L^l_s, \theta^l_s) = (210,129;65,202°)
\]
\[
(x^l_e, y^l_e; L^l_e, \theta^l_e) = (149,153;65,202°)
\]
\[
(x^l_w, y^l_w) = (89,177)
\]
\[
(x^r_s, y^r_s; L^r_s, \theta^r_s) = (310,129;65,348°)
\]
\[
(x^r_e, y^r_e; L^r_e, \theta^r_e) = (373,142;65,348°)
\]
\[
(x^r_w, y^r_w) = (437,156)
\]
\[
(x^l_H, y^u_H; x^r_H, y^d_H) = (210,209;310,268)
\]
\[
(x^l_h, y^l_h; L^l_h, \theta^l_h) = (236,268;105,271°)
\]
\[
(x^l_k, y^l_k; L^l_k, \theta^l_k) = (237,372;105,271°)
\]
\[
(x^l_a, y^l_a) = (239,477)
\]
\[
(x^r_h, y^r_h; L^r_h, \theta^r_h) = (295,268;103,272°)
\]
\[
(x^r_k, y^r_k; L^r_k, \theta^r_k) = (298,370;103,272°)
\]
\[
(x^r_a, y^r_a) = (302,473)
\]
Results and Discussions
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Although the most of extracted HB-frameworks from the front-viewed standing HB-image are reasonable, it is worthy of further exploring some phenomena in our work, e.g., influence between the color of clothes and that of hand skin, influence between the color of trousers and that of shoes, influence of self-clothes and self-trousers, ratio limitation of the framework with the detected face size, incomplete information of trousers segmentation, unclear trousers boundary occurring between left and right legs, hip down boundary depending on the detected face size, and hip joint possibly located inside the hip region.
Results and Discussions

The inherent limits of the proposed approach are as follows. The front-viewed face should be at normal top of the trunk. The HB-framework is designed to be front-viewed. Only the long sleeves of clothes and the long trousers are allowed. Some scales used in the proposed method depend on the statistics of a set of limited human body information. The arm parts (and leg parts) cannot overlap each other.
Results and Discussions

As a future work, based on the found phenomena and the inherent limits of currently developed approach, the corresponding solutions may be good researching topics and are worthy of further studying.

Thank you for your attention