Regression-Based Locating Landmark on Dynamic Humans

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ABSTRACT

We present a novel framework that consists of two-level regressors for finding correlations between human shapes and landmark positions in both body part and holistic scales. To this end, we first develop pose invariant coordinates of landmarks that represent both local and global shape features by using the pose invariant local shape descriptors and their spatial relationships. Our body part-level regression deals with the shape features from only those body parts corresponding to a certain landmark. For this, we develop a method that identifies such body parts per landmark, by using geometric shape dictionary obtained through the bag of features method. Our method is nearly automatic, requiring human assistance only once to differentiate the left and right sides, and shows the prediction accuracy comparable to or better than those of existing methods, with a test data set containing a large variation of human shapes and poses.

CCS CONCEPTS

• **Computing methodologies** → *Learning linear models*; *Shape analysis*;

KEYWORDS

KCCA, regression, segmentation, landmark detection

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1 INTRODUCTION

Analyzing and understanding human body shapes are important problems in computer graphics research, with a number of applications such as registration, retargeting, and shape retrieval. Anatomical landmarks on human bodies are essential features for obtaining anthropometric information, but detecting the anatomical landmarks remains a challenging problem due to high variedness of human shapes and poses.

A conventional approach for landmark detection is by finding correspondences between a template body model with annotated landmarks and a particular body shape, typically through mesh registration methods [Chui and Rangarajan 2003]. This registration-based approach is effective for the body shapes similar to the template, but has a limited capability in generalizing to the whole range of human shapes with different poses. A more principled and potentially powerful approach would be learning and predicting the relationship between various body shapes and their landmark locations. In addition, a good method should not require complex preprocessing, such as alignments, on the input data.

In this paper, we solve the anatomical landmark detection problem on human models with dynamic poses, by training a statistical regression model that learns connections between human body shapes and landmarks. When trained with a data set of a wide range of human shapes and poses, the regression-based method achieves a higher performance than registration-based approaches.

2 OUR APPROACH

Specifically, we show that the kernel canonical correlation analysis (KCCA) method successfully models the correlation between human body shapes and landmarks.

We develop several key ideas that enable robust landmark detection against severe variations in shape and pose. First, we develop a novel method that serves as pose invariant coordinates of landmarks. This is achieved by representing the position of a landmark with the feature vector in the pose invariant, local descriptor space. In addition, since the mapping from vertices to local descriptor space is non-injective (e.g., left and right Stylions have the same feature vector), we augment this representation with the spatial relationship information between landmarks, which is also described in a pose invariant manner.

Second, in order to increase the regression accuracy, we develop a two-level regression method that separately regresses body part-level features and holistic features. The part-level regressor models the connection between the local feature of a landmark and the shape of the body parts that are related with the landmark. To identify such body parts per landmark, we develop a method that uses geometric shape dictionary obtained through the supervised bag of features (S-BoF [Litman et al. 2014]) method. The segmentation of body parts allows for training the lower-level regressor with respect to the only body parts that are related with the landmark, and thus blocks the effect from other unrelated body parts. The global level regressor relates the holistic shape characteristics with the spatial relationship between landmarks, and this overcomes the non-injectivity of local features and allows for finding landmarks nearly automatically.

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