A Method of Human Posture Recognition Based on Skeletal Feature Analysis

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Abstract

In order to improve the recognition rate in Human Posture Recognition problem and to deal with the restricted number of postures, this paper introduce new human posture recognition method based on analyzing the skeletal features. The skeletal features are then extracted for posture classifier together with important coefficients between features of each posture for more accuracy outcome. We do the experiment with various numbers of postures and the comparison with other methods is shown to evaluate the performance of this method

Keywords: Pattern classification, Human-Robot interaction, human body recognition, skeleton tracker

1. Introduction

There are two main problems that we have to deal with in human posture recognition. The first one is how to improve the recognition rate and reduce time computation. The second problem is the limitation of number of main postures classified. Most of undergoing methods just deal with four or five clusters with the acceptable recognition rate. Many researches [1, 3, 5] show that if the number of clusters is increase, the result is worse.

In this paper, we introduce new method to recognize 8 human postures. The method based on analyzing the whole human skeleton feature. The rest of this paper is Methodology; Skeletal feature; Implementation and conclusion.

2. Methodology

A simplified scheme of the approach is given in Fig. 1. The first step is to detect the human skeleton from the sequence of image frames. The whole skeleton is then extracted, processed and the skeletal feature vector is obtained for training and recognizing progress. Based on the analysis of each recognized posture, we propose 8-dimentional feature vector. Through the training progress, the cluster feature vector is extracted together with the weighted vector. The weighted vector characterizes for the influence of each component to the main posture that represents this cluster.

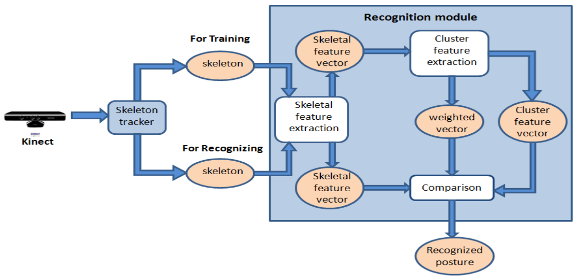

Fig. 1. The simplified scheme showing the posture recognition approach.

In this paper, we selected 8 main postures: Standing, Bending, Sitting, Lying, Climbing, Fighting, Jumping and Pointing.

3. Skeletal feature extraction

We have 8-demensional skeleton feature vector for each posture:

$$\vec{p} = (p_1, p_2, ..., p_8) = (h1, \angle elbow_{left}, \angle elbow_{right}, \angle knee_{left}, \angle knee_{right}, \angle spine, h_{body}, h_{center}) \quad (3.1)$$

The skeletal feature vector components are calculated as shown in fig. 2.

Now, we calculate the mean vector (Eq.3.2) and the weighted vector (Eq.3.4) for each cluster based on the dataset. The weighted vector is the main contribution of this paper. As we mentioned above, each component of the skeleton feature influences to recognition process differently. The weighted vector is calculated basing on the standard deviation of each component. The lower the standard deviation is, the more important the component is.

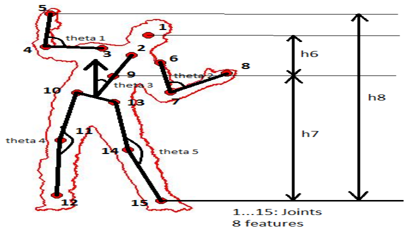

Fig. 2. Detail of 8 features

$$\overrightarrow{F^k} = \frac{1}{N}\sum_{i=1}^{N}\overrightarrow{p_i} = (F_1^k, F_2^k, ..., F_S^k) \quad (3.2)$$

$$\overrightarrow{\sigma^k} = (\sigma_1^k, \sigma_2^k, ..., \sigma_S^k), k = \overline{1, K}$$

$$\sigma_f{}^k = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{p_{if}^k - F_f{}^k}{F_f{}^k}\right)^2, f = \overline{1, S} \quad (3.3)$$

$$\overrightarrow{w^k} = (w_1^k, w_2^k, ..., w_S^k)$$

$$w_f^k = \frac{\sum_{i=1}^{S}\frac{1}{\sigma_i{}^k}}{\sigma_f{}^k}, k = \overline{1, K}, f = \overline{1, S} \quad (3.4)$$

Where,

$\overrightarrow{F^k}$: mean of k-th cluster feature vector.

$\overrightarrow{w^k}$: weighted vector of k-th cluster.

S: size of skeleton feature vector (S=8)

Because the components of skeleton vector are measured in different units, the standard deviation is normalized for calculation of w_f^k .

4. Experiment results

For recognition, we calculate the correlation between this skeletal feature vector and cluster feature vector.

$$C^k(\vec{p}) = \sum_{i=1}^{S} w_i^k \left(\frac{p_i - F_i^k}{F_i^k}\right)^2, k = \overline{1, K}$$

$$where, \sum_i w_i^k = 1$$

The posture $\vec{p}$ is assigned to the cluster p^* that corresponds to the maximum value of correlation.

$$p^* = \arg(\underset{k}{Max}(C^k(\vec{p})))$$

The results for 4-posture and 8-posture case are respectively: 100, 94, 97, 100 (%) and 91, 92, 88, 96, 84, 90, 80 (%). We also compare with other methods for 4-posture case in fig. 3

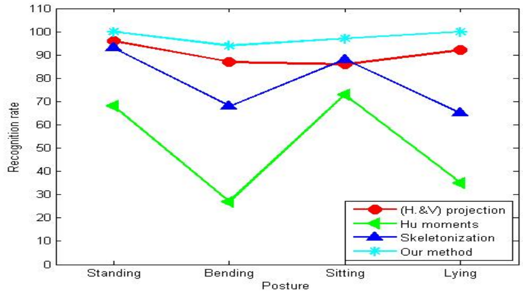

Fig. 3. Comparison to other methods

5. Conclusion

We have introduced a method to recognized 8 human postures. Relying on the collection of 3D image data sequence through Kinect camera, we analyze skeleton features and extract 8 key features for recognition. The key contribution of this method is using the weighted vector that obtained in extracting cluster feature progress. This make the outcome be improved with average recognition rate of 88.6 %.

References

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