Extraction of a Feature of a Word Expressing a Human Motion from Motion Capture Data

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1 Introduction
In this study, we propose a method to quantify a relation between a feature of a human motion and a word used to express its name using the subspace method. Motion name is divided into some words, and it is examined which component of a feature vector is related to each word. The proposed method is applicable to a motion database [Yukawa et al. 2000]. Using this method, 1) a search key can be automatically generated from the relationship between the features of motion data and their name when inserting human motion data into the database, and 2) we can search required human motion data from the database using a motion word as a query in the same way as is used in a search engine of a web system.

2 Methods and Results
The recorded motion data are standardized for a position, an angle, and a scale for preparations of processing. Then the data are divided to some segments called a motion clip to make it easy to reuse them. We resample each motion clip data by n points at equal intervals and use the value of the points as a feature vector of a motion clip. The learning motion clip data to which the motion name is assigned are prepared beforehand to determine the relation between the element of the feature vector of a motion clip and its name. A set of the motion data \(X_i\) which use word \(w_i\) as a motion name is created from learning data. The autocorrelation matrix \(R_i\) of the feature vector of a motion clip which uses word \(w_i\) is given by

\[
R_i = \frac{1}{n_i} \sum_{x \in X_i} xx^T.
\]  

(1)

Let \(u_j\) be the eigen vector derived from \(j\)-th eigen value \(\lambda_j\) \((j=1, ..., d)\). Then a transform matrix \(P_j\) which transforms a feature vector space to subspace \(L_j\) expressing a feature of word \(w_i\) is given by

\[
P_j = \sum_{j=1}^{d_i} u_j u_j^T.
\]  

(2)

Here, \(d_i\) is the dimension of subspace and is decided by the accumulation contribution rate of eigen value \(\lambda_j\). Since orthogonal projection from feature vector \(x\) for a motion clip to subspace \(L_j\) is \(P_jx\), we define participation degree \(S_i(x)\) by the square length of \(P_jx\). That is

\[
S_i(x) = x^TP_jx = \sum_{j=1}^{d_i} (x^Tu_j)^2.
\]  

(3)

When one motion clip data is inserted into a database, a feature vector for the motion clip is calculated for all words used in a learning motion name.

If \(n\) is the number of motion clips inserted into a database and \(m\) is the number of words used in learning data, then for all \(j=1...n\) and \(i=1...m\), we make a matrix of size \(n \times m\) whose elements consist of participation degree \(S_i(x)\). We can know how much feature of a word is included certain motion clip by examining this matrix. This matrix, which is called an identification dictionary, can be used as an index of a motion database.

On the other hand, we can obtain required motion clip by calculating a sum of participation degree of a row in an identification dictionary for a word given as a search query. A motion clip having a large value of calculated sum is similar to the required motion. If \(W\) is a set of motion words and \(P(w_i)\) is a probability of existence for a word \(w_i \in W\), then we define a similarity degree between \(W\) and motion clip \(i\) as

\[
Q_i = \sum_{w_j \in W} (-\log P(w_j)) \cdot S_{ij}.
\]

(4)

Similarity degree \(Q_i\) is calculated for all motion clips in an identification dictionary, and motion clips sorted in a descending order of a similarity degree is shown to a user as searched results.

We evaluated the effectiveness of the proposed method by developing the motion clip searching system. Figure 1 shows the best three searched results of the “JODAN AGÉ UKE” which is one of the defense technique of KARETE-DO. We can find out that a specified motion clip was well searched by the proposed method.

3 Conclusion
In this paper, we have proposed a method to quantify a relation between human motion data and a word used in a motion name. As a result of the experiment, we confirmed that a motion database constructed by the proposed method was effective and that it could be a good candidate for searching a motion clip by its name.

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References

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![Fig. 1 Search experimental result](image)