

Coupled Motion Capture and Text Analysis of the Bon Odori Dances of Akita Prefecture

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For many years, the top three *Bon Odori* dances of Akita Prefecture, i.e., *Hitoichi Bon Odori*, *Kemanai Bon Odori* and *Nishimonai Bon Odori*, have attracted a great deal of attention. Recently, an approach using motion capture (Mocap) data gave successful outcomes in the motion analysis of these dances. On the other hand, several survey reports on these dances have been compiled to record their histories and current states. The text data of these reports provide a lot of valuable knowledge about the dances themselves and their surrounding environment. With these facts taken into consideration, we try to perform coupled Mocap and text analysis of these dances. In Mocap data analysis, we extract rhythmic-style feature quantities; they are converted into qualitative expressions. As for text data analysis, we extract sentences describing the characteristics of the dances; each sentence is ranked by the frequencies of the phrasal units used in it. As the first stage of this approach, we use part of the text data of the survey reports. As a result of the analysis, the cause of bringing about a motion feature unique to *Hitoichi Bon Odori* (wide distribution of rhythmic style) was clarified to a certain extent. At the same time, it is also pointed out that there are several points to be improved in this approach.

1. Introduction

Akita Prefecture, located in the Tohoku region of Japan, has many important intangible folk cultural properties designated by the national government or the local public entities. In particular, the top three *Bon Odori* (盆踊り)*¹ dances of Akita Prefecture, i.e., *Hitoichi Bon Odori* (一日市盆踊り), *Kemanai Bon Odori* (毛馬内盆踊り) and *Nishimonai Bon Odori* (西馬音内盆踊り), have attracted a great deal of attention. It is seen in recent years that their motion is analyzed by using motion capture (Mocap) data [1]. This approach gave successful outcomes such as that motion features peculiar to each dance were quantitatively clarified [1].

On the other hand, several survey reports on the three *Bon Odori* dances have been compiled to record their histories and current states [2]-[4]. They provide a lot of valuable knowledge such as the origin of each dance and its form of succession. By efficiently uti-

lizing the provided knowledge in accordance with the information obtained from Mocap data, the relationship between the motion style of the dances and their surrounding environment is expected to become more understandable. Fortunately, many text-mining techniques, which extract important knowledge from unstructured text resources, have been developed in recent years. They may be effective in efficiently extracting valuable knowledge from the text data of the survey reports.

With the above facts taken into consideration, we try to perform coupled Mocap and text analysis of the top three *Bon Odori* dances of Akita Prefecture. As the first stage, we perform Mocap data analysis and text data analysis in parallel. In Mocap data analysis, we extract the rhythmic style of the three dances, using the analysis method of Ref. [1]. The obtained results are arranged so as to be comparable with those of text data analysis. Specifically, we convert the feature quantities of rhythmic style into qualitative expressions. As for text data analysis, we extract sentences describing the characteristics and background of each dance and those related to the relationship of multiple dances.

*¹ *Bon Odori* is a type of Japanese folk dance, performed during the annual Buddhist festival called *O-Bon* (お盆) (or simply *Bon* (盆)).

2. Top three *Bon Odori* dances of Akita Prefecture

Since the home ground of *Hitoichi Bon Odori*, i.e., the Hitoichi district of Hachirogata Town, exists in the coastal area of Akita Prefecture, it is regarded as one of the dances of Coastal Area Group [5]. *Hitoichi Bon Odori* consists of the following three dances: *Dendenzuku Odori* (デンデンヅク踊り), *Kitasaka Odori* (キタサカ踊り) and *Sankatsu Odori* (三勝踊り)*2). *Hitoichi Bon Odori* was designated as an Akita Prefectural intangible folk cultural property in 2002.

On the other hand, *Kemanai Bon Odori* is regarded as belonging to Yoneshiro River System Group [5]; the Kemanai district of Kazuno City is adjacent to a tributary of Yoneshiro River. *Kemanai Bon Odori* consists of the following two dances: *Dainosaka Odori* (大の坂踊り) and *Jinku Odori* (甚句踊り). *Kemanai Bon Odori* was designated as a national important intangible folk cultural property in 1998.

As for *Nishimonai Bon Odori*, it is regarded as one of the dances of Omono River System Group, since the *Nishimonai Bon Odori* festival is held in Ugo Town including part of Omono River System [5]. *Nishimonai Bon Odori* consists of the following two dances: *Ondo* (音頭) and *Ganke* (がんげ)*3). *Nishimonai Bon Odori* was designated as a national important intangible folk cultural property in 1981.

The Mocap data of the above dances analyzed in this study are shown in **Table 1**. Multiple data streams are prepared at every dance. These data are identical to those used in Ref. [1].

3. Motion-Capture Data Analysis

3.1 Extraction of rhythmic-style feature quantities

In Mocap data analysis, two feature quantities of rhythmic style are extracted: beat intensity and rhythm complexity [1], [6]. First, we obtain a one-dimensional motion-speed time series from the displacement of $J=16$ points (shoulders, elbows, wrists, fingers, knees, ankles, toes, neck and head):

$$v(n) = \frac{\sqrt{\sum_{j=1}^J \sum_{\gamma=x,y,z} \{p_{j,\gamma}(n+1) - p_{j,\gamma}(n)\}^2}}{\Delta t} \quad (1)$$

where $p_{j,\gamma}(n)$ ($\gamma: x, y$ or z) is the γ -coordinate of the j th point at the n th frame (coordinate system: fixed to the pelvis) and Δt is the sampling time ($\Delta t = 0.033$ sec), respectively. The values of $p_{j,\gamma}(n)$'s are filtered to eliminate jitter (by using a Gaussian filter, cut-off frequency: 9.0 Hz), and normalized by the body

*2 Some documents describe this dance name as “サンカツ踊り,” not as “三勝踊り” (pronunciation: identical).
*3 Some documents describe this dance name as “ガソケ” or “願化,” not as “がんげ” (pronunciation: all identical).

Table 1 Motion capture data of *Bon Odori* dances.

Dance	Index	Number of frames	Dancer	
<i>Hitoichi Bon Odori</i> (一日市盆踊り)	<i>Dendenzuku Odori</i> (デンデンヅク踊り)	#1 #2 #3	195 200 195	A A A
	<i>Kitasaka Odori</i> (キタサカ踊り)	#1	163	A
		#2	156	A
		#3	170	A
		#4	167	A
		#5	163	A
		#6	190	A
	<i>Sankatsu Odori</i> (三勝踊り)	#1	353	A
		#2	367	A
		#3	359	A
		#4	322	A
	<i>Kemanai Bon Odori</i> (毛馬内盆踊り)	<i>Dainosaka Odori</i> (大の坂踊り)	#1	308
#2			323	B
#3			343	B
<i>Jinku Odori</i> (甚句踊り)		#1	294	B
		#2	276	B
		#3	324	B
<i>Nishimonai Bon Odori</i> (西馬音内盆踊り)	<i>Ondo</i> (音頭)	#1	1,341	C
		#2	1,336	C
		#3	1,326	D
		#4	1,341	D
	<i>Ganke</i> (がんげ)	#1	1,236	C
		#2	1,231	C
		#3	1,235	D
		#4	1,219	D

Frame rate: 30 fps

Motion capture: Magnetic-sensor systems

Hitoichi: MotionStar Wireless™ (Ascension Technology Corporation)

Kemanai and *Nishimonai*: MotionStar Wireless™ with LIBERTY™ (Polhemus) ×2

Dancers

A: Female (with more than ten years' experience in dancing *Hitoichi Bon Odori*)

B: Female (with more than ten years' experience in dancing *Kemanai Bon Odori*)

C: Female (with more than ten years' experience in dancing *Nishimonai Bon Odori*)

D: Female (with more than ten years' experience in dancing *Nishimonai Bon Odori*)

height to reduce the influence of difference in body constitution.

By using the above time series, we estimate the degree of beat intensity (BI) as follows:

$$BI = \frac{1}{2} \log \frac{\sum_{n=1}^N \{v(n) - v_0(n)\}^2}{N} - A \log(\tau \Delta t) \quad (2)$$

where τ is the frame number giving the first positive peak of the autocorrelation of $v(n)$ (regarded as the beat interval), $v_0(n)$ is the moving average of $v(n)$ (period: τ), N is the total number of frames and A is the weighting coefficient to the beat-interval element $\tau \Delta t$ (set as $A = 0.2$), respectively. The first term of this formula evaluates the strength of motion-speed surges inducing beats, whereas the second term evaluates the pace of tempo. The stronger motion-speed surges are, or the quicker the tempo is, the larger the value of BI

becomes.

As for rhythm complexity, on the other hand, the value of approximate entropy (ApEn) [7], [8] obtained from $v(n)$ is used:

$$\begin{aligned} \mathbf{x}(n) &= [v(n) \quad v(n+\tau') \quad \cdots \quad v(n+(m-1)\tau')]^T \\ d(\mathbf{x}(n), \mathbf{x}(j)) &= \max_{k=1,2,\dots,m} (|v(n+(k-1)\tau') - v(j+(k-1)\tau')|) \\ C_n^m &= \frac{\sum_{j=1}^{N-(m-1)\tau'} \theta(r - d(\mathbf{x}(n), \mathbf{x}(j)))}{N - (m-1)\tau'} \\ \Phi^m &= \frac{\sum_{n=1}^{N-(m-1)\tau'} \log C_n^m}{N - (m-1)\tau'} \\ \text{ApEn} &= \Phi^m - \Phi^{m+1} \end{aligned} \quad (3)$$

where $\tau' = \text{round}(0.2\tau)$, $m = 3$, $r = 0.25 \times$ (standard deviation of $v(n)$) and $\theta(x)$ is the Heaviside function, respectively. The ApEn value becomes large when the variation of motion speed shows a large amount of complexity.

The distribution of the rhythmic-style feature quantities of all the Mocap data in Table 1 is shown in **Figure 1**. This distribution is identical to that shown in Figure 6 of Ref. [1].

3.2 Conversion of rhythmic-style feature quantities into qualitative expressions

As mentioned in Section 1, we convert the above feature quantities into qualitative expressions. The procedures used for the above conversion are shown in **Figure 2**. In Stage 1, first, feature-quantity values are grouped by a clustering algorithm. This algorithm is separately applied to each feature quantity. Here, Ward's method [9] is adopted as a clustering algorithm. Combining Ward's method with Mojena's Stopping Rule One [10] allows us to automatically obtain an appropriate number of clusters*4.

Next, we fix the positions of boundaries between the clusters to determine the range of each cluster. As shown in Stage 2 of Figure 2, we use the middle point between the endpoints of adjacent clusters as the boundary of these clusters. The range of the k th cluster is given as the interval $[b(k-1, k), b(k, k+1))$ where $b(k-1, k)$ is the boundary between the $(k-1)$ th and k th clusters. In Stage 3, then, we assign the analyzed dances to the clusters. Which cluster each dance belongs to is specified by the centroid position of the data set of the dance; a cluster having a range including the centroid of a certain dance is regarded as the assignment destination of this dance,

*4 The constant used in Mojena's Stopping Rule One is set as $k = 1.25$ which is the value recommended in Ref. [11].

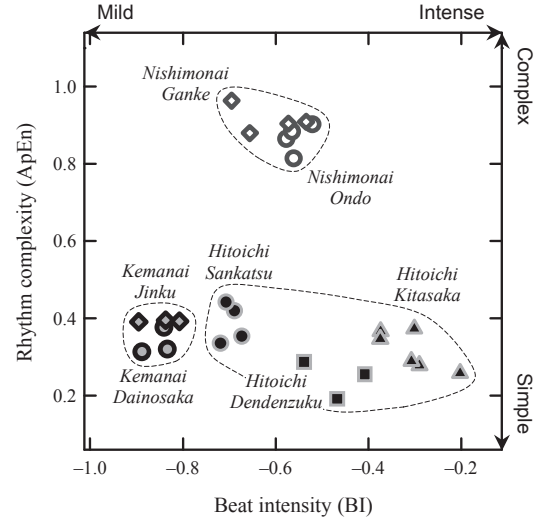


Figure 1 Distribution of rhythmic-style feature quantities.

as shown in Figure 2.

In Stage 4 of Figure 2, we assign qualitative expressions to the clusters. We use an l -point scale composed of any of the following pairs of bipolar adjectives [12]: “Mild”-“Intense” (for beat intensity) or “Simple”-“Complex” (for rhythm complexity) (each of them was already shown in Figure 1). The algorithm used for the assignment process is shown in **Figure 3**. In the case that the number of the clusters is an odd number, the cluster located at the center of the series of the clusters is regarded as corresponding to a neutral selection (e.g., “Neither Mild nor Intense”). In the case that the number of the clusters is an even number, on the other hand, the boundary located at the center of the series of the boundaries is regarded as representing the neutral position. In this case, no cluster corresponds to a neutral selection. Although the number of points in a scale, l , is selected in response to the number of the clusters, at the same time it is restricted to five or under in this algorithm.

In Stage 5, finally, qualitative expressions are given to the dances in accordance with the assignment to the clusters, as shown in Figure 2. The results obtained from the data of Figure 1 are shown in **Figure 4**. The values of beat intensity were converted into qualitative expressions obtained from a three-point scale consisting of the following categories: “Mild,” “Neither Mild nor Intense” and “Intense.” As for rhythm complexity, a two-point scale consisting of the categories “Simple” and “Complex” was selected. The broken lines in Figure 4 represent the boundaries between the clusters. The list of qualitative expressions including relative relations between the dances is shown in **Table 2**. The expressions of the relative relations, i.e., the off-diagonal elements of Table 2, were manually selected based on the qualitative expressions of the individual dances, i.e., the diagonal

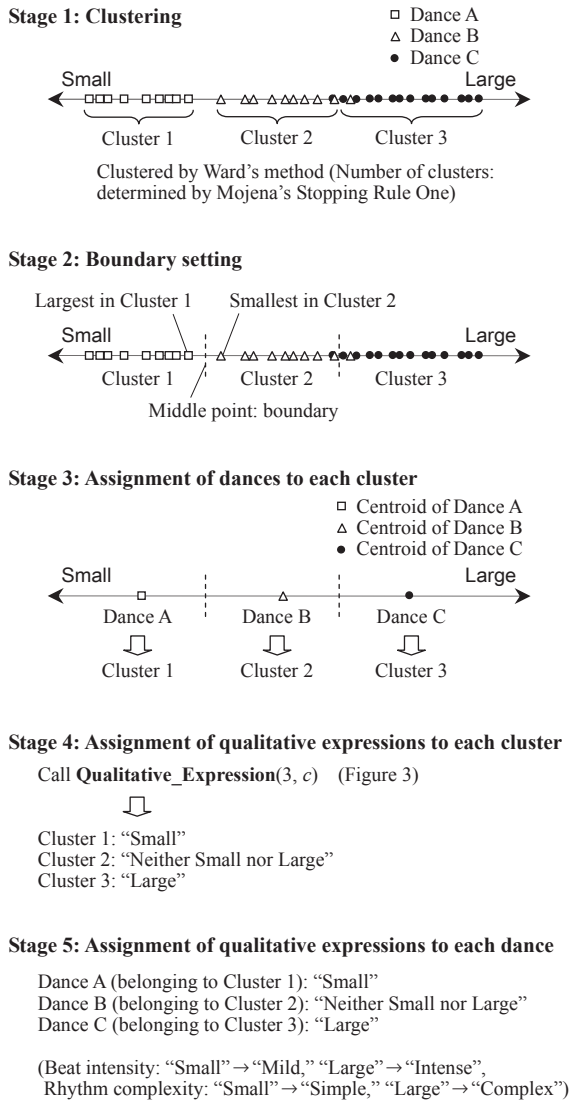


Figure 2 Conversion of the feature-quantity values of rhythmic style into qualitative expressions.

elements.

It is shown in the above results that each of the three *Bon Odori* dances has its own characteristics. In particular, only *Hitoichi Bon Odori* shows a unique feature that the members of this dance are distributed into multiple categories, whereas each of the remaining two *Bon Odori* dances concentrates on a single category.

4. Text Data Analysis

4.1 Procedures used for text data analysis

In text data analysis, sentences including the names of the *Bon Odori* dances are first extracted. Specifically, sentences each of which includes at least one of the ten dance names shown in Table 1 are extracted. Next, the extracted sentences are categorized based on the dance names included in them. A sentence

```

Qualitative_Expression(K, c)
/* K: Number of clusters */
/* c(i): Qualitative expression for the i-th cluster */
input K
if K is an odd number then
  k ← int(K/2) + 1
  if K ≥ 5 then
    for i = 1 to K do
      j ← i - k
      if j ≤ -2 then
        c(i) ← "Extremely Mild/Simple"
      else if j = -1 then
        c(i) ← "Slightly Mild/Simple"
      else if j = 0 then
        c(i) ← "Neither Mild/Simple nor Intense/Complex"
      else if j = 1 then
        c(i) ← "Slightly Intense/Complex"
      else
        c(i) ← "Extremely Intense/Complex"
      end if
    end for
  else /* if K ≤ 3 then */
    for i = 1 to K do
      j ← i - k
      if j = -1 then
        c(i) ← "Mild/Simple"
      else if j = 0 then
        c(i) ← "Neither Mild/Simple nor Intense/Complex"
      else
        c(i) ← "Intense/Complex"
      end if
    end for
  end if
if K is an even number then /*
  if K ≥ 4 then
    k ← K/2
    for i = 1 to K do
      j ← i - k
      if j ≤ 0 then j ← j - 1
      if j ≤ -2 then
        c(i) ← "Extremely Mild/Simple"
      else if j = -1 then
        c(i) ← "Slightly Mild/Simple"
      else if j = 1 then
        c(i) ← "Slightly Intense/Complex"
      else
        c(i) ← "Extremely Intense/Complex"
      end if
    end for
  else /* if K = 2 then */
    c(1) ← "Mild/Simple"
    c(2) ← "Intense/Complex"
  end if
output c(i)'s (1 ≤ i ≤ K)
  
```

Figure 3 Algorithm to assign qualitative expressions to each cluster.

including only a single name is categorized as that describing the characteristics of a corresponding dance. A sentence including two names is sorted into the category assigned to the pair of corresponding two dances. This type of sentence is treated as that describing the relationship between two dances. When a single sentence includes three or more names, we sort it into multiple dance-pair categories (i.e., overlapping of categories is permitted.).

After categorizing the extracted sentences, each of the sentences is ranked at every category. A score,

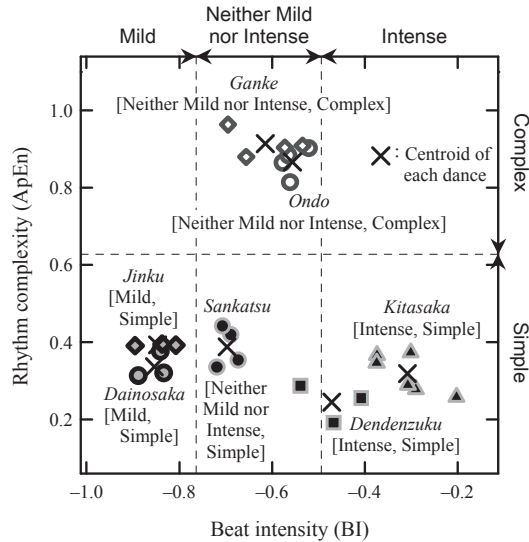


Figure 4 Qualitative expressions of rhythmic-style features.

given by adding up the frequencies of the phrasal units (each called 文節 in Japanese grammar) regarded as the main constituents of a sentence, is used for ranking. The types of phrasal units selected as the above constituents are as follows: the declinable word (用言) having a dependency relation with a dance name, the argument (項) associated with a selected declinable word through a case particle (格助詞), and the phrasal unit modifying a dance name or a selected argument. To obtain the above grammatical information from text data written in Japanese, we perform Japanese predicate-argument structure analysis [13] using JUMAN (Ver. 7.0) and KNP (Ver. 4.0). In the scoring process, the frequencies of the dance names are not used; we adopt the policy that we count only the phrasal units explaining the characteristics of the dances, exclusive of the dance names themselves. An example of scoring is shown in Figure 5. Sentences giving high scores in each category are regarded as those providing valuable knowledge.

4.2 Results of text data analysis

As the first stage, we analyze part of Ref. [2]: Pre-

face, Comments from the General Editor, Sections 3.1 and 3.3 and Chapter 4 (written in Japanese, total number of characters: 24,076). The numbers of the extracted sentences in each category are shown in Table 3. Table 4 shows the sentences each corresponding to the single dance name belonging to the top three *Bon Odori* dances. Table 5 shows the sentences corresponding to the relative relations between the dance names belonging to the above three dances.

From the descriptions of the underlined sentences in Table 5, we can see that *Hitoichi Bon Odori* belongs to the dance type different from that of *Kemanai Bon Odori* and *Nishimonai Bon Odori*. (former: *Odoru Odori*, latter: *Miseru Odori* and *Nenbutsu Odori*). From the second sentence for *Hitoichi Bon Odori* shown in Table 4, furthermore, we can reason that the interaction of the Hitoichi district with neighboring areas may have caused the expanse of this dance. These descriptions relatively well explain why only the Mocap data of *Hitoichi Bon Odori* give a unique rhythmic-style feature, i.e., the distribution of rhythmic style into multiple categories.

To understand the situation of the expanse of *Hitoichi Bon Odori* more deeply, we use the sentences describing the relative relations of the dances belonging to *Hitoichi Bon Odori*; Table 6 shows part of these sentences. The underlined sentences describe that *Dendenzuku Odori* and *Kitasaka Odori* have been recognized as dances easy to dance with a quick tempo, whereas *Sankatsu Odori* has been regarded as a dance with a graceful slow tempo. These descriptions are consistent with the qualitative expressions obtained from the Mocap data (shown in Table 2). In addition, the sixth sentence in the *Dendenzuku Odori – Kitasaka Odori* category suggests that the origin of *Sankatsu Odori* may be different from that of the remaining two. This description well explains why only the Mocap data of *Sankatsu Odori* belong to the different category.

5. Discussion

From the results of the Mocap data analysis, we can see that only *Hitoichi Bon Odori* shows the plu-

Table 2 Qualitative expressions of the rhythmic-style features of *Bon Odori* dances obtained from Mocap data.

	<i>Hitoichi Bon Odori</i>			<i>Kemanai Bon Odori</i>		<i>Nishimonai Bon Odori</i>	
	<i>Dendenzuku</i>	<i>Kitasaka</i>	<i>Sankatsu</i>	<i>Dainosaka</i>	<i>Jinku</i>	<i>Ondo</i>	<i>Ganke</i>
<i>Dendenzuku</i>	Intense, Simple	Identical	More Intense	Far More Intense	Far More Intense	More Intense, Simpler	More Intense, Simpler
<i>Kitasaka</i>	Identical	Intense, Simple	More Intense	Far More Intense	Far More Intense	More Intense, Simpler	More Intense, Simpler
<i>Sankatsu</i>	Milder	Milder	Neither Mild nor Intense, Simple	More Intense	More Intense	Simpler	Simpler
<i>Dainosaka</i>	Far Milder	Far Milder	Milder	Mild, Simple	Identical	Milder, Simpler	Milder, Simpler
<i>Jinku</i>	Far Milder	Far Milder	Milder	Identical	Mild, Simple	Milder, Simpler	Milder, Simpler
<i>Ondo</i>	Milder, More Complex	Milder, More Complex	More Complex	More Intense, More Complex	More Intense, More Complex	Neither Mild nor Intense, Complex	Identical
<i>Ganke</i>	Milder, More Complex	Milder, More Complex	More Complex	More Intense, More Complex	More Intense, More Complex	Identical	Neither Mild nor Intense, Complex

Example sentence:

このように、広い地域で踊られていた盆踊りの原型を一日市盆踊りは引き継いでいます。 (Ref. [2], p.1, translated into English by the authors.)
 Thus, *Hitoichi Bon Odori* has inherited the archetype of the *Bon Odori* dance danced in a wide area.

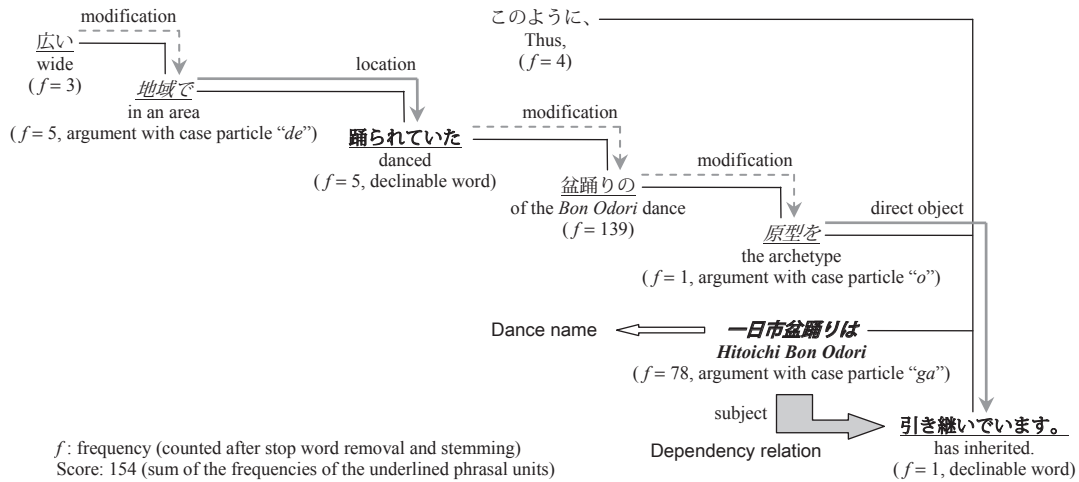


Figure 5 An example of the scoring of a sentence written in Japanese (predicate-argument structure analysis: JUMAN (Ver. 7.0) and KNP (Ver. 4.0)).

Table 3 Numbers of extracted sentences in each category

	Hitoichi Bon Odori			Kemanai Bon Odori			Nishimonai Bon Odori		
	Dendenzuku	Kitasaka	Sankatsu	Dainosaka	Jinku	Ondo	Ganke		
Hitoichi Bon Odori	70	1	1	3	0	3	0		
Dendenzuku	/	2	12	0	0	0	0		
Kitasaka	/	/	0	8	0	0	0		
Sankatsu	/	/	/	19	0	0	0		
Kemanai Bon Odori	/	/	/	/	1	1	0		
Dainosaka	/	/	/	/	/	0	0		
Jinku	/	/	/	/	/	0	0		
Nishimonai Bon Odori	/	/	/	/	/	/	0		
Ondo	/	/	/	/	/	/	1		
Ganke	/	/	/	/	/	/	0		

Table 4 Extracted sentences corresponding to the single dances belonging to the top three *Bon Odori* dances.

Hitoichi Bon Odori: 70 sentences (3 higher-ranking sentences are shown.)	
1. 地域によって呼び名が異なるが、踊りの種類や使用する楽器、盆踊りの際に仮装をすることなど、周辺地域と一日市盆踊りとはあまり差はみられない。 (As can be seen in the commonness)* In the dancing style, the musical instruments and the custom that dancers masquerade while dancing, no significant difference between the ones in neighboring areas and <i>Hitoichi Bon Odori</i> is found, although they are called differently depending upon the area. (Ref. [2], p.62, score: 371)	
2. 盆踊りの形態が似ているために、湖東周辺地域と交流があったことも一日市盆踊りを大きくした要因であると思われる。 It is thought that interaction with the Koto area, attributable to the similarity of the forms of <i>Bon Odori</i> dances, is also a contributing factor leading to the expanse of <i>Hitoichi Bon Odori</i> . (Koto area: one of the areas neighboring the Hitoichi district)* (Ref. [2], p.68, score: 290)	
3. また、はじめにも述べたが、踊りに決まった型はなく、踊りたい人が自由に踊ることの出来る雰囲気を持っていることが、一日市盆踊りを発展させた重要な要素であると思われる。 As mentioned earlier, on the other hand, it is thought that the dance style whose form is not prescribed and the atmosphere allowing people to freely dance are important factors leading to the development of <i>Hitoichi Bon Odori</i> . (Ref. [2], p.45, score: 263)	
Kemanai Bon Odori: 1 sentence	
1. 毛馬内盆踊りと同じく念仏踊り系といわれている。 It is said to be the <i>Nenbutsu Odori</i> type as with <i>Kemanai Bon Odori</i> . (<i>Nenbutsu Odori</i> : type of Japanese folk dance)* (Ref. [2], p.2, score: 15)	
Nishimonai Bon Odori: no sentence is extracted. (Translated into English by the authors, *: translation annotation added by the authors.)	

rality of rhythmic-style features. In addition, the sentences extracted by the text data analysis gave the information related to the cause of this tendency. This suggests that the collaboration between Mocap data analysis and text data analysis is really effective. However, the amount of the analyzed text data is still

small in the present stage. In fact, no explanation about the difference between *Kemanai Bon Odori* and *Nishimonai Bon Odori* shown in Table 2 is given. There is an urgent need to increase the amount of text data used in the analysis.

There is also a problem, on the other hand, that not

Table 5 Extracted sentences in the categories of the relative relations between the dances belonging to the top three *Bon Odori* dances

Relative relation between <i>Hitoichi Bon Odori</i> – <i>Kemanai Bon Odori</i> : 3 sentences	
1.	<u>西馬音内盆踊り、毛馬内盆踊りが「見せる踊り」とすると、一日市盆踊りは「踊る踊り」と言われる。</u> <i>Hitoichi Bon Odori</i> is said to be “ <i>Odoru Odori</i> ,” whereas <i>Nishimonai Bon Odori</i> and <i>Kemanai Bon Odori</i> are regarded as “ <i>Miseru Odori</i> .” (<i>Odoru Odori</i> : a dance recommended to be danced by all the people attending the <i>O-Bon</i> festival, <i>Miseru Odori</i> : a dance to be appreciated)* (Ref. [2], p.38, modified to adapt to text processing, score: 86)
2.	<u>一日市盆踊りの醸し出す雰囲気が念仏踊り系の毛馬内盆踊りや西馬音内盆踊りとは違うのもうなずける訳です。</u> It is agreeable that the atmosphere of <i>Hitoichi Bon Odori</i> is different from that of <i>Kemanai Bon Odori</i> and <i>Nishimonai Bon Odori</i> both belonging to the <i>Nenbutsu Odori</i> type. (<i>Nenbutsu Odori</i> : type of Japanese folk dance)* (Ref. [2], p.1, score: 17)
3.	<u>ではいつから一日市盆踊りが西馬音内盆踊り、毛馬内盆踊りと並び、県内三大盆踊りの一つと呼ばれるようになったのだろうか。</u> Then, when did <i>Hitoichi Bon Odori</i> come to be called one of the top three <i>Bon Odori</i> dances of Akita Prefecture along with <i>Nishimonai Bon Odori</i> and <i>Kemanai Bon Odori</i> ? (Ref. [2], p.64, score: 4)
Relative relation between <i>Hitoichi Bon Odori</i> – <i>Nishimonai Bon Odori</i> : 3 sentences	
(Identical to the <i>Hitoichi Bon Odori</i> – <i>Kemanai Bon Odori</i> category)	
Relative relation between <i>Kemanai Bon Odori</i> – <i>Nishimonai Bon Odori</i> : 4 sentences	
1.	<u>西馬音内盆踊り、毛馬内盆踊りが「見せる踊り」とすると、一日市盆踊りは「踊る踊り」と言われる。</u> <i>Hitoichi Bon Odori</i> is said to be “ <i>Odoru Odori</i> ,” whereas <i>Nishimonai Bon Odori</i> and <i>Kemanai Bon Odori</i> are regarded as “ <i>Miseru Odori</i> .” (Ref. [2], p.38, modified to adapt to text processing, score: 86)
2.	<u>一方、「念仏踊り」は毛馬内盆踊りや西馬音内盆踊りのように踊り手と歌い手が分かれたものをさすようである。</u> On the other hand, it seems that “ <i>Nenbutsu Odori</i> ” refers to the ones in which dancers and singers are separated from each other, such as <i>Kemanai Bon Odori</i> and <i>Nishimonai Bon Odori</i> . (Ref. [2], p.29, score: 50)
3.	<u>一日市盆踊りの醸し出す雰囲気が念仏踊り系の毛馬内盆踊りや西馬音内盆踊りとは違うのもうなずける訳です。</u> It is agreeable that the atmosphere of <i>Hitoichi Bon Odori</i> is different from that of <i>Kemanai Bon Odori</i> and <i>Nishimonai Bon Odori</i> both belonging to the <i>Nenbutsu Odori</i> type. (Ref. [2], p.1, score: 17)
4.	<u>ではいつから一日市盆踊りが西馬音内盆踊り、毛馬内盆踊りと並び、県内三大盆踊りの一つと呼ばれるようになったのだろうか。</u> Then, when did <i>Hitoichi Bon Odori</i> come to be called one of the top three <i>Bon Odori</i> dances of Akita Prefecture along with <i>Nishimonai Bon Odori</i> and <i>Kemanai Bon Odori</i> ? (Ref. [2], p.64, score: 4)

Underlined sentences: common in all the pairs of the dances belonging to the top three *Bon Odori* dances.
(Translated into English by the authors, *: translation annotation added by the authors.)

all high-score sentences necessarily give information comparable with Mocap data; e.g., the fourth sentence in the *Dendenzuku Odori* – *Kitasaka Odori* category shown in Table 6 is not directly related to Mocap features (only the description about the lyrics of the songs is given). The development of an algorithm to automatically extract sentences highly relevant to Mocap features will be the subject of future work.

6. Conclusions

As shown in the above discussion, we clarified several points to be improved in the coupled Mocap and text analysis of the *Bon Odori* dances of Akita Prefecture, as the first stage of this approach. It is expected that an attempt to solve the above problems will further expand our knowledge about the folk performing arts of Akita Prefecture.

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Table 6 Extracted sentences in the categories of the relative relations between the members of *Hitoichi Bon Odori*.

Relative relation between <i>Dendenzuku Odori</i> – <i>Kitasaka Odori</i> : 12 sentences (6 higher-ranking sentences are shown.)	
1.	<u>圧倒的にサンカツの時間が短いことも分かるが、「デンデンヅク」「キタサカ」を比べても「デンデンヅク」の方に多く時間を割いていることが分かる。</u> We can see that the performance time of “ <i>Sankatsu</i> ” is overwhelmingly short, and by comparing “ <i>Dendenzuku</i> ” with “ <i>Kitasaka</i> ,” we can also see that much more time is spent on “ <i>Dendenzuku</i> .” (Ref. [2], p.39, score: 170)
2.	<u>特定の衣裳はなく、思い思いの着装（平成十四年近隣の若美町福米沢盆踊りに、米俵を身にまとう裸足の踊り手を記録）の踊り手がダイナミックにクイックテンポで「デンデンヅク」「キタサカ」と優雅なスローテンポの「サンカツ」を踊る。</u> There is no particular costume, and dancers each wearing his/her own costume (a barefoot dancer wearing a straw rice bag was recorded at the <i>Fukumezawa Bon Odori</i> festival in the nearby town of Wakami in 2002) dance “ <i>Dendenzuku</i> ” and “ <i>Kitasaka</i> ” with a quick tempo and “ <i>Sankatsu</i> ” with a graceful slow tempo. (Wakami Town: one of the areas neighboring the Hitoichi district)* (Ref. [2], p.2, score: 100)
3.	<u>このように、「デンデンヅク」や「キタサカ」は「サンカツ」と比べて非常に踊りやすい単純な踊りであることが分かる。</u> We can thus see that both of “ <i>Dendenzuku</i> ” and “ <i>Kitasaka</i> ” are simple dances far easier to dance as compared with “ <i>Sankatsu</i> .” (Ref. [2], p.45, score: 86)
4.	<u>キタサカやデンデンヅクにはいくつかの歌詞があり、時代によって生まれたり消えたりしていく歌がある。</u> There are several set of lyrics for <i>Kitasaka</i> and <i>Dendenzuku</i> , and there are songs created reflecting, or those falling into decline along with, the current of the times. (Ref. [2], p.68, score: 77)
5.	<u>また、デンデンヅクやキタサカには共通の歌詞があり、時代や地域を反映したものが多く。</u> On the other hand, there are the lyrics common in <i>Dendenzuku</i> and <i>Kitasaka</i> , many of which reflect the period and the region. (Ref. [2], p.39, score: 76)
6.	<u>もともとはキタサカとデデズク（デンデンヅク）と二種類しかなかったものです。（“だす” is an Akita dialect meaning “です.”）*</u> Originally there had been only two types, <i>Kitasaka</i> and <i>Dedezuku</i> (<i>Dendenzuku</i>). (Ref. [2], p.38, score: 56)
Relative relation between <i>Dendenzuku Odori</i> – <i>Sankatsu Odori</i> : 7 sentences (3 higher-ranking sentences are shown.)	
1.	<u>圧倒的にサンカツの時間が短いことも分かるが、「デンデンヅク」「キタサカ」を比べても「デンデンヅク」の方に多く時間を割いていることが分かる。</u> We can see that the performance time of “ <i>Sankatsu</i> ” is overwhelmingly short, and by comparing “ <i>Dendenzuku</i> ” with “ <i>Kitasaka</i> ,” we can also see that much more time is spent on “ <i>Dendenzuku</i> .” (Ref. [2], p.39, score: 170)
2.	<u>特定の衣裳はなく、思い思いの着装（平成十四年近隣の若美町福米沢盆踊りに、米俵を身にまとう裸足の踊り手を記録）の踊り手がダイナミックにクイックテンポで「デンデンヅク」「キタサカ」と優雅なスローテンポの「サンカツ」を踊る。</u> There is no particular costume, and dancers each wearing his/her own costume (a barefoot dancer wearing a straw rice bag was recorded at the <i>Fukumezawa Bon Odori</i> festival in the nearby town of Wakami in 2002) dance “ <i>Dendenzuku</i> ” and “ <i>Kitasaka</i> ” with a quick tempo and “ <i>Sankatsu</i> ” with a graceful slow tempo. (Ref. [2], p.2, score: 100)
3.	<u>このように、「デンデンヅク」や「キタサカ」は「サンカツ」と比べて非常に踊りやすい単純な踊りであることが分かる。</u> We can thus see that both of “ <i>Dendenzuku</i> ” and “ <i>Kitasaka</i> ” are simple dances far easier to dance as compared with “ <i>Sankatsu</i> .” (Ref. [2], p.45, score: 86)
Relative relation between <i>Kitasaka Odori</i> – <i>Sankatsu Odori</i> : 8 sentences (4 higher-ranking sentences are shown.)	
1.	<u>圧倒的にサンカツの時間が短いことも分かるが、「デンデンヅク」「キタサカ」を比べても「デンデンヅク」の方に多く時間を割いていることが分かる。</u> We can see that the performance time of “ <i>Sankatsu</i> ” is overwhelmingly short, and by comparing “ <i>Dendenzuku</i> ” with “ <i>Kitasaka</i> ,” we can also see that much more time is spent on “ <i>Dendenzuku</i> .” (Ref. [2], p.39, score: 170)
2.	<u>特定の衣裳はなく、思い思いの着装（平成十四年近隣の若美町福米沢盆踊りに、米俵を身にまとう裸足の踊り手を記録）の踊り手がダイナミックにクイックテンポで「デンデンヅク」「キタサカ」と優雅なスローテンポの「サンカツ」を踊る。</u> There is no particular costume, and dancers each wearing his/her own costume (a barefoot dancer wearing a straw rice bag was recorded at the <i>Fukumezawa Bon Odori</i> festival in the nearby town of Wakami in 2002) dance “ <i>Dendenzuku</i> ” and “ <i>Kitasaka</i> ” with a quick tempo and “ <i>Sankatsu</i> ” with a graceful slow tempo. (Ref. [2], p.2, score: 100)
3.	<u>山本郡の「サンカツ」の歌詞は「踊るも跳ねるも今夜ばかり、明日から田圃の稲刈りだ キタサカ キタサカ キタサカ サッサ」とあり、一日市盆踊りの「キタサカ」とまったく同じ歌詞、同じ囃子である。</u> The lyrics of “ <i>Sankatsu</i> ” in Yamamoto District are given as “This is the last night for dancing and jumping, rice harvest will be started tomorrow, <i>kitasaka kitasaka kitasaka sassa</i> ,” and these lyrics and their accompaniment are exactly the same as with those of “ <i>Kitasaka</i> ” of <i>Hitoichi Bon Odori</i> . (Yamamoto District: one of the areas neighboring the Hitoichi district)* (Ref. [2], p.28, score: 91)
4.	<u>このように、「デンデンヅク」や「キタサカ」は「サンカツ」と比べて非常に踊りやすい単純な踊りであることが分かる。</u> We can thus see that both of “ <i>Dendenzuku</i> ” and “ <i>Kitasaka</i> ” are simple dances far easier to dance as compared with “ <i>Sankatsu</i> .” (Ref. [2], p.45, score: 86)

Underlined sentences: common in all the pairs of the dances belonging to *Hitoichi Bon Odori*.
(Translated into English by the authors, *: translation annotation added by the authors.)

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