Japanese Sentence Input Method Using Acceleration Sensor

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Abstract. Digital pens are used for character input method without training. Some lecture support systems were developed by using pen input, because of collecting remarks of student in a real time. We proposed a lecture support system by using Wiimote for character input method. Because Wiimote has 3D acceleration sensor, a student writes a character in the air, and our system can recognize a written character. After that the recognized character is displayed on an electronic blackboard. We are using two recognition algorithms by only real-stroke. And we adopt the error correction method by using a tree search algorithm that uses word dictionary. The Japanese characters used in this paper are Hiragana (71 characters), Katakana (71 characters), Kanji (1006 characters taught elementary schools in Japanese) and numerals. The recognition accuracy was 78.9%. Also, the recognition accuracy of phrase was 91.7% by bi-gram model. We confirmed the required performance for utilization.

Keywords: Character Recognition, Wiimote, Gesture Recognition, N-gram Model.

1 Introduction

Digital pens are used for character input method without training. Some lecture support systems were developed by using pen input, because of collecting remarks of student in a real time. We proposed a lecture support system by using Wiimote for character input method. Because Wiimote has 3D acceleration sensor, a student writes a character in the air, and our system can recognize a written character. After that the recognized character is displayed on an electronic blackboard. The advantage of our system is simple equipment investment.to aggregate student's opinion, other systems need input device such as a pair of pen-tablet and personal computer for each student, but out system enable it with Wiimote only.

We are using two recognition algorithms by only real-stroke. However, it was difficult to distinguish similar characters to use these methods that are the recognition algorithm for the one character order. Therefore we adapt the error correction method by using a tree search algorithm that uses word dictionary.

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2 Input Method of Japanese Sentence by Using Wiimote

The way of writing a letter is: users push the “B” button, and release it whenever they finish writing one stroke. And, users push the “A” button when they finish writing one letter.

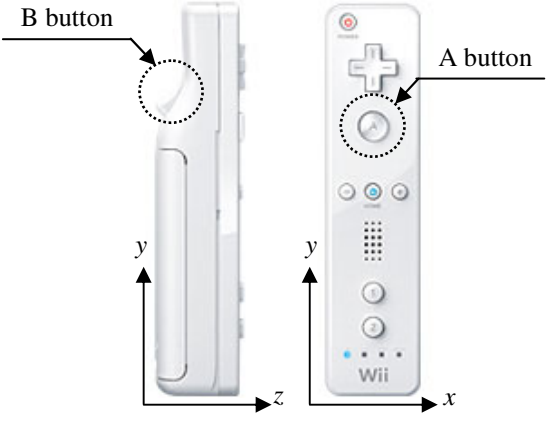

Fig. 1. Wiimote and axes

3 Improvement of Character Recognition Method

3.1 Reconstruction of Written Character Shape

We adopted bi-axial accelerations (x-z plane) gotten from tri-axial acceleration sensor of Wii remote. This method is described below. As a preparation, we integrate acceleration got from acceleration sensor of Wii remote, and calculate velocity. Then, we integrate it again, and calculate trajectory of Wiimote. But, gravity acceleration is always included in z-axis. We have to rid gravity acceleration for us to calculate trajectory. When analyzing frequencies of acceleration, we realized that the frequency of gravity acceleration appeared as DC component. So, we removed gravity acceleration by using high-pass filter. Figure 2 shows reconstructed characters of Japanese.

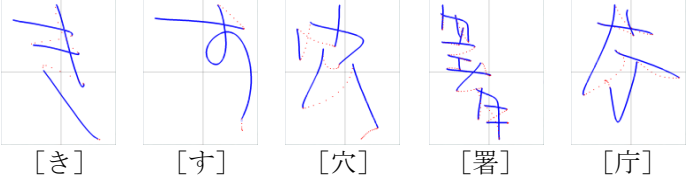

Fig. 2. Reconstructed shapes

3.2 Character Recognition Method

Written characters are recognized by using trajectory gotten from preparation. Two kinds of character recognition algorithm; namely, the TRRS (Time Ratio of Real Stroke) method and the LSDS (Line Segment Directions in a Stroke) method [1] have been proposed for this system. TRRS method is based on the time ratio of real strokes (trait). A feature parameter set is expressed as a set of codes that correspond to each line's input time ratio. We defined codes from 0 to 7. Here, let R_i and F_i denote the direction in the i^{th} stroke on a template and give an evaluation value as follows;

$$P_i = \begin{cases} 2, if\ \ F_i = R_i \\ 1, if\ F_i = R_i \pm 1 \\ 0, Others \end{cases} \tag{1}$$

The corresponding sum of the P_i

$$T_{TRRS} = \frac{\sum_{i=1}^{N} P_i}{2N} \tag{2}$$

is calculated.

We checked that real stroke is relatively-stable feature quantity. We can't give an accuracy value from an imaginary stroke (an imaginary stroke means an imaginary line between a pen-up point of the stroke and a pen-down point of the following stroke). LSDS method is that a stroke is divided into several line segments by the same segment length. A feature parameter set is expressed as a set of eight direction codes that correspond to each line segment. Here, let $R_{i,j}$ and $F_{i,j}$ denote the direction of the j^{th} line segment in the i^{th} stroke on a template and give an evaluation value as follows;

$$Q_{i,j} = \begin{cases} 2, if\ F_{i,j} = R_{i,j} \\ 1, if\ \ F_{i,j} = R_{i,j} \pm 1 \\ 0, Others \end{cases} \tag{3}$$

The corresponding sum of the $Q_{i,j}$,

$$T_{LSDS} = \frac{\sum_{i=1}^{N} \sum_{j=1}^{n} Q_{i,j}}{2nN} \tag{4}$$

is calculated where n means a segment number on a certain stroke. The combination of the two methods is desirable to recognize all type of Japanese character written by using Wii remote. This method is named the Fusion method in this paper. The sum of the T_{TRRS} and T_{LSDS} is used as recognition in the Fusion method. Adding weight ratios (W_{TRRS} and W_{LSDS}) of the T_{TRRS} and T_{LSDS} are 50:50 in the case of the character having more than three strokes and 0:100 in the case of one stroke character in the following formula.

$$T_F = W_{TRRS} \cdot T_{TRRS} + W_{LSDS} \cdot T_{LSDS} \tag{5}$$

3.3 Error Correction Method

It was difficult to distinguish similar characters to use the Fusion method for one-character order. Therefore we adapt the error correction method by using n-gram model. The candidate character sequences are produced from each characters transition probability and the character pattern similarity.

Then the system outputs the 1st candidate phrases using Viterbi algorithm. In the normal algorithm, to calculate all combinations of characters takes time for extract the 2nd and 3rd candidate phrases. Thus, we adapt simplification algorithm for the reduction of the processing time in our system. It is re-calculated to replace only one character from the 1st candidate phrase. In almost all cases, only one character of a character sequence has mistaken from a correct phrase. Therefor our proposed simplification algorithm is effective from a viewpoint of the both of processing time and a recognition improvement.

4 Performance of Recognition Accuracy

We tested the performance of the proposed improvement recognition algorithm. The Japanese characters used in this paper are Hiragana (71 characters), Katakana (71 characters), Kanji (1006 characters taught elementary schools in Japanese) and numerals. The recognition accuracy was 78.9% in the 1st candidate by using the Fusion method (Table 1).

The recognition accuracy of the 1st candidate phrase was 91.7% by bi-gram model (Table 2).

Table 1. Performance of recognition (One-character order)

Candidate	TRRS	LSDS	Fusion
1st	54.5%	68.3%	78.9%

Table 2. Error correction method performance of recognition (Phrase order)

Method	Tester A	Tester B	Tester C	Average
Fusion only	78.1%	74.3%	81.0%	77.8%
Fusion with Error correction	92.3%	92.9%	90.0%	91.7%

5 Conclusion

We proposed Japanese sentence input method using Wiimote as acceleration sensor. We are using two recognition algorithms by only real-stroke. One of recognition algorithm is LSDS method. However, this method doesn't adapt if a stroke length is short. Therefore, the other recognition algorithm is TRRS method that it uses the ratio at the input time of each stroke.

However, it was difficult to distinguish similar characters to use these methods that are the recognition algorithm for the one character order. Therefore we adapt the error correction method by using a tree search algorithm that uses word dictionary.

The recognition accuracy was 78.9%. Also, the recognition accuracy of phrase was 91.7% by bi-gram model. We confirmed the required performance for utilization.

Reference

1. Ezaki, N., Kiyota, K., Kamei, T., Takizawa, H., Yamamoto, S.: An Improvement in the Character Recognition Accuracy in the On-line Japanese Input System for Blind Persons. Japanese Society for Medical and Biological Engineering 40(4) (2002)