

Design of a Server for Online Handwriting Recognition

Daqing WANG[†], Bilan ZHU^{††}, Masaki NAKAGAWA^{††}

Department of Computer and Information Science, Tokyo University of Agriculture and Technology
Naka-cho 2-24-16, Koganei-shi, Tokyo, 184-8588, Japan

E-mail : [†]dqwanggz@hotmail.com, ^{††}{zhubilan, nakagawa}@cc.tuat.ac.jp

Abstract This paper describes the design of an online handwritten characters recognition server. Currently, fast and accurate recognition of online handwritten characters requires a high-performance CPU and a large memory space. However, PDA and other small portable devices lack the qualification. To solve this problem, we employ a network environment and build an on-line handwritten characters recognition server system. The paper discusses network data flow transmission, client/server architecture and presents a demo application.

Key words Recognition Server, Online Handwriting, Client/Server, Continuous Writing.

1. Introduction

In recent years, due to the development of pen input devices such as Tablet PCs, electronic whiteboards, PDAs, digital pens (like the Anoto pen) and so on, handwritten text recognition as an input method has been given a considerable attention.

However, PDA and other small portable devices give an unsatisfied performance due to limited processing performance and memory limitation. As a result, accurate processing in real-time recognition is difficult, especially, in continuous writing with less constraint for handwritten text recognition [1]. In addition, desktop systems and electronic whiteboards as sufficient hardware resources are available, the cost to maintain accurate handwriting recognition engine cannot be ignored.

At present, there are so many servers for the speech recognition, [2] and [3] both had given a good construction model. However, for online handwritten character recognition server, the research is scarce, and most systems are based on application program. Sakurada et al. [4] refers to the applications of an online handwritten character recognition server, but it was just tailored for the limited applications.

In this paper, to provide an online handwritten character recognition service and to solve problems existing in the small portable devices, as shown in Figure 1, we propose building an online handwritten character recognition server system based on Linux to offer an online recognition service and present a construction model to allow rich interaction with users. Consequently, small devices can provide the best performance in real-time.

Section 2 discusses the client/server architecture, and describes handle procedure of the server. Section 3 describes our online handwritten character recognition engine using the

latest technology. Section 4 gives the experiment results to show that building an online handwritten character recognition server is feasible. Section 5 draws conclusion.

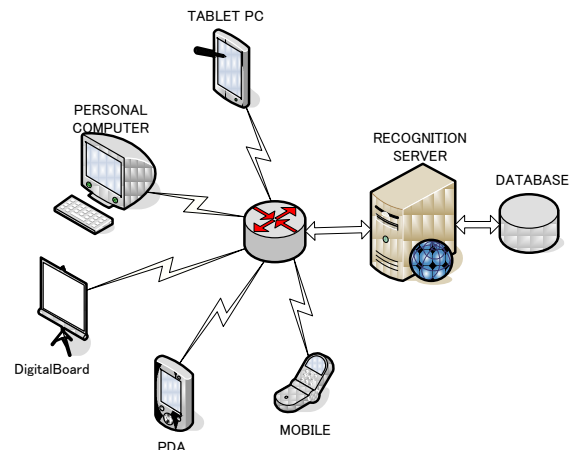


Figure 1. Online Handwritten Character Recognition Server

2. Client/Server Architecture

The design of client/server architecture arises from common net structure where a server offers online handwritten character recognition for client's programs. We can learn some strategies and techniques from [5]. In our experiment, sampling of digital ink (a series of pen-tip coordinates from pen-down to pen-up) and preprocessing run only on client's side. These ink data are transferred to the recognition server via Internet. Finally, the recognized text is sent back to client's writing application. The architecture of system is shown in Figure 2.

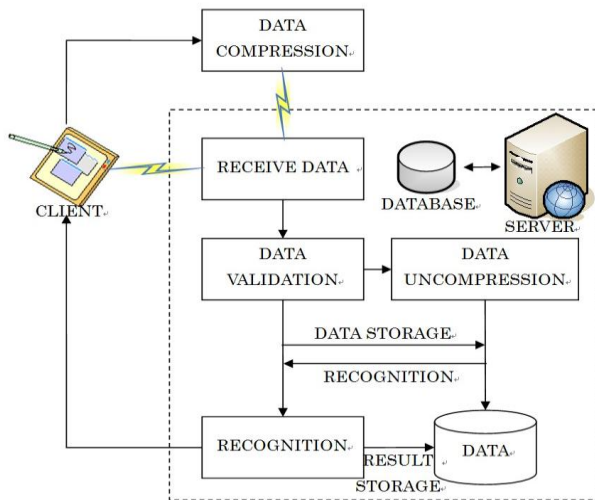


Figure 2. System Architecture

Network transmission is based on TCP / IP protocol, the entire transfer process is as follows:

Firstly, the client collects ink data, and sends them to the server. Data transmission can be divided into non-compressed format and compressed format. Compressed format also can be divided into lossless compression and lossy compression. We employ a lossy compression which is used for character recognition so that it does not degrade recognition performance. The client takes that role from the server since it decreases the transmission cost.

It extracts feature points in the ink data. The method is often applied in on-line handwritten character recognition field. As shown in Figure 3, first, the starting point and the end of every stroke are picked up as feature points. Then, the most distance point from the straight line between adjacent feature points is selected as a feature point if the distance to the straight line is greater than a threshold value. This is applied recursively until no more feature point is selected. The feature points extracting process is shown in Figure 3. Due to the fact that unselected points cannot be restored, this is lossy compression. We also call a sequence of selected feature points as digital ink.

Before sending digital ink, it is encoded with header data, so that it can be handled by the Server. Besides, the Server supports Http protocol via a CGI program, offering an interface of XML data format. XML is a textual data format, and is widely used for the representation of arbitrary data structure. In [6], Jon Bosak gives a description of it, and the SVG image is also organized by XML.

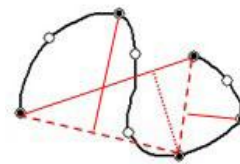


Figure 3. Feature Points

Secondly, on the server side, when a user was authorized, the server creates a connection, receives data, and checks the data; only the correct data format can be recognized. After data validation, according to the data header information it decompresses the data, which directly goes to be recognized. According to user needs, the server determines to store the data or not. Finally, send back the recognition results to the client application. In addition, the server also supports the keep-alive and non-alive connection. The Server is a shared resource, and the client without response for a long time can take the non-alive connection in order to save the Server resources, while the frequent interaction client can take keep-alive connection to improve the response speed.

3. Recognition Engine

Our online handwritten character recognition engine combines online recognizer and offline recognizer for Japanese [7]. The recognition process is as following (Figure 4):

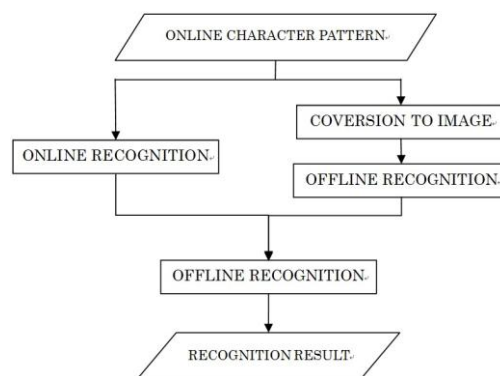


Figure 4. Combined Recognition Process

The system provides on-line handwritten Japanese text recognition without writing box constraints that evaluates the likelihood of recognition candidates according to the evaluation criterion proposed in [1] that combines the scores of character recognition, geometric features (character pattern sizes, inner gaps, single-character positions, pair-character positions, candidate segmentation points) and language context with the weighting parameters estimated by the genetic algorithm. The recognition accuracy is as following

table (Table 1). The database that evaluates our proposed combined recognizer for Japanese character recognition is HANDS-kuchibue_d_97_06 written by 120 participants, each composed of 11,951 character patterns written by a single participant [9]. And the character string recognition was evaluated by a Japanese online handwriting database HANDS-Kondate_t_bf-2001-11 that collected from 100 people [1].

Table 1. Recognition Rate

Type	Recognition Rate
Character Recognition [8]	92.2%
Text Recognition [1]	92.80%

4. A Demo of Client Application

Figure 5 shows an example of a client application that in our experiment is used to test the recognition server system.

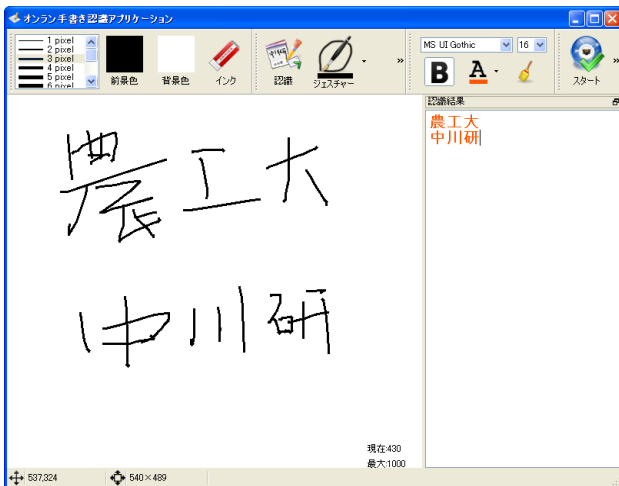


Figure 5. User Interface of a Client Application

Our recognizer combines an on-line recognizer and an off-line recognizer to allow both cursive handwriting and stroke order free recognition, but it is for each character pattern. If a user adds some strokes after writing another character, they are not correctly recognized. This happens when a user add missing strokes later or overwrite strokes on characters written previously. This system allows the user to teach correct segmentation into each character pattern by encircling its strokes as shown in Figure 6. To allow this interaction, the client application can reorder the strokes according to encircling information, and then the server can re-recognize the strokes again to get the correct result.

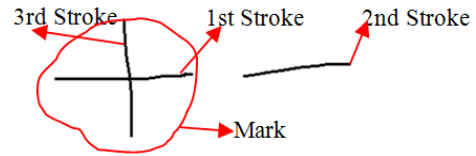


Figure 6: Writing not in Order

5. Experiment and Results

In the actual experiment with a 10M/100M wireless switch, we have verified that our system performs the continuous writing with less constraints and returns recognition result in real-time. Moreover, we have also observed that our client/server architecture processes handwritten patterns at much higher speed than many of the clients running on their own client-side character recognition. The response time is similar to a stand-alone system where character recognition applications run on a computer with more or less processing power. The reason is that our recognition program is running on a high-performance server computer, and the response time is determined by a network environment, rather than handling speed of the clients. The experiments results are shown in Table 2.

Table 2. Response time of the same string [ms]

Client PC Configure	Client/Server			Client-side
	Min.	Aver.	Max.	
Celeron T3100 1.90GHz	78	148.5	203	160
Genuine T2300 980MHz	79	154.6	235	204

6. Conclusion

The proposed system provides online handwritten character recognition applications via network for a common PC, or a small portable device without high-performance hardware requirements. It is expected to widen the application area of pen-based, paper-based or handwriting-based interfaces. We have confirmed that two or more character recognition applications can use a single recognition server at the same time. The response time is similar to a stand-alone system where character recognition applications run on a computer with more or less processing power. The response time strongly depends on connection speed. In the future we are going to propose higher data flow transmission, and provide an interface of other wireless transmission, and support even more devices.

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