MokkAnnotator – A System for Archiving Mokkan Images

Truyen Van PHAN a, Hajime BABA b, Akihiro WATANABE b, and Masaki NAKAGAWA a

a Graduate School of Technology, Tokyo University of Agriculture & Technology
2-24-16, Naka-cho, Koganei, 184-8588, Tokyo, JAPAN

b Nara National Research Institute for Cultural Properties
2-9-1 Nijyo-cho, Nara, 630-8577, Nara, JAPAN
truyenvanphan@gmail.com, hajime@nabunken.go.jp

Abstract. This paper describes a support system for archaeologists to accumulate, annotate and retrieve images of mokkans, which have been excavated from ancient ruins such as Heijyo-Palace. The term “mokkan” is a generic name given to Japanese historical wooden tablets on which characters were written with brush and ink called sumi. More than 200,000 of the 370,000 mokkans unearthed in Japan come from excavations of Heijyo-Palace and its surrounding ruins. These historical documents have been drawn much attention because of their high archaeological values. Since most of mokkans have been stained, damaged and degraded, it is difficult even for experts on archaeology to read or decode them. Furthermore, the number of mokkans is increasing as excavations continue, so that the problem is getting more and more serious. Some methods have been proposed to help archaeologists decode them employing Information Technology. Nevertheless, an archival system is essential which accumulate images of mokkans effectively and incorporate useful functions for reading mokkans. In this work, we have designed and developed a support system for accumulating mokkan images and registering excavation information from the early stage of excavation. In order to save time and work of archaeologists, information registration is almost done automatically by the system. In addition, we have incorporated image processing functions for archaeologists to decode and annotate mokkans. We have also organized functions under GUI through which they can use the system without being familiar with computers. As a result, mokkan images are efficiently accumulated with their excavation information and annotation, managed by a database, made available through Web and shared by many experts and people.

1. Introduction

Historical documents are obviously invaluable and essential to know the history. In recent years, digitization and digital archives of historical documents have been advanced and played a key role in cultural properties preservation and management. We became able to access, process and analyze these valuable documents electronically. Furthermore, we can publish electronic information to the public, which expands rapidly the range of information sharing.

The same situation applies to wooden tablets excavated from ancient ruins which are classified as a type of ancient documents. “Mokkan” is a Japanese generic name which refers to wooden tablets used as documents in ancient Japan as shown in Figure 1(a). They were widely used as a means of communication in Nara period (from 710 to 794). From mokkans, we could learn the flow of materials, the relations among regions and the condition of economy at the period. Therefore, there is an increasing interest in the results of decoding mokkans.

Unfortunately, however, in most of unearthed mokkans, the color of ink has been faded, the surfaces of mokkans have been scratched and the wooden tablets have been broken dung the time over 1200 years in the underground. Hence, the decoding of mokkans is extremely difficult. As excavations in the larger remaining parts continue, the number of mokkans is increased that are preserved and remained to be decoded. In fact, in the Heijyo 440th excavation from Nov 2008 to Feb 2009, a large incinerator pit was found. Then about 2,600 cases of muddy mokkans were unearthed and most of them were shavings of the surfaces of wooden tablets as shown in Figure 1(b).

After excavation, fragments of mokkans are placed on glass plates and glass plates are placed in a tray with preservative liquid. The archaeologists are now archiving these mokkan fragments with their digital images. Since, handwritten characters are unreadable on more than 90% of fragments, their decipherment is considered unfeasible.

Figure 1. (a) Examples of mokkans and (b) mokkan fragments from the Heijyo Palace site.

Due to this problem, we have been designed and developed an infrastructural system called MokkAnnotator for archaeologists to accumulate mokkan images and register information from the early stage
of the excavation (Phan et al., 2011). Since mokkan images are managed with their excavation information and annotation, stored in a database, made available through Web and shared by many experts and people, it is expected to enlarge utilization of mokkans later. Since the previous version of MokkAnnotator was introduced, we have improved the system to allow users to accumulate mokkan images and register information more effectively. Hereafter, Section 2 shows the overview of the archival system. Section 3 describes the detail of the improvement, and Section 4 draws summary and future work.

2. The overview of MokkAnnotator

MokkAnnotator is a support system for archaeologists to accumulate, annotate and retrieve images of mokkans.

Figure 2(a) shows the concept of MokkAnnotator. The general process is started with selecting an image of a glass plate on which about 10 fragments of mokkans are placed (hereafter, we call it glass plate image). A user then refers to the excavation information table and input the general data for the glass plate image. As the main task of annotation, the user defines zones for individual images of mokkan fragments and input the particular data for them. Eventually, images and metadata can be viewed or printed through user interface, exported to CSV file, and stored to a database. In addition, the user can search into the database if he/she wants to refer, edit or analysis the annotated glass plate image and mokkan fragments.

Figure 2. (a) The concept and (b) interface of MokkAnnotator.

MokkAnnotator is developed in the C# language with Japanese interface. It is composed of 7 components: menu (A), navigation bar (B), project explorer (C), toolbar (D), display area (E), property window (F), and annotated data window (G) as shown in Figure 2(b). Through this interface, MokkAnnotator provides a set of functions for archaeologists to accumulate and organize mokkan images: image and metadata display, image processing, zones manual drawing or automatic defining, zones editing, text annotating, reference id automatic re-arranging, data exporting and storing, searching, and printing. Among them, the project explorer component and the image processing function are added in the revised version.

3. The revised version of MokkAnnotator

The improved version contains reformation of the interface, incorporation of the image processing functions for decoding mokkans, revision of the automatic zone-definition method and construction of the mokkan images database and website to publish on Web.

3.1 Reformed graphical user interface

In the previous version, a user registers, annotates and edits contents through a SDI (Single Document Interface). At a time, a user can only open a glass plate image and work on it. In this version, we have changed the type of interface to MDI (Multiple Document Interface). Multiple glass plate images can be opened in separate tabs in tiling window interface or separate windows in floating window interface. These two types of window managers are interchangeable freely.

We can think that a glass plate and a tray are corresponding to a file and a project in computer. Hence, we have provided the project container to help managing the glass plate images more efficiently. We have constructed the project explorer and incorporated it into the interface to view and manage image files.

3.2 Incorporated image processing functions

Since mokkans on image vary in size, placement orientation and background color, it is necessary to apply image processing to make them more readable. Therefore, we have incorporated the brightness/contrast adjustment, scaling and rotating functions into the system. These processing can be applied to not only the whole image but also a specified area defined by a user or an individual mokkan fragment. The image processing for archaeologists to read scripts on mokkans is divided into two sub processes: preprocessing and ink detection. In the preprocessing, the brightness/contrast adjustment method and the contrast enhancement method can emphasize ink part. On the other hand, in the ink detection, the similar pixel detection method and the
Binarization methods convert the image into a binary image. The contrast enhancement method and the similar pixel detection method are proposed by Takakura et al. (2010). The results of these methods are shown in Figure 3. The binarization methods are global thresholding methods for various kinds of documents and they are Otsu (Otsu, 1979), SIS (Kittler et al., 1985), Huang, Yen, Li, Mean, Moments, Iterative, IsoData, Percentile, MaxEntropy. The image processing techniques provide archaeologists with a wide choice to decide which enhancement method is to be applied to make mokkan images readable through a form as shown in Figure 5(a).

![Figure 3. (a) Effect of contrast enhancement and (b) similar pixel detection.](image1)

### 3.3 Revised automatic zone-definition method

In the previous method, we binarize the whole glass plate image by using the SIS thresholding method, extract mokkan image region by using projection histogram, and then detect individual mokkan fragments by using contour labeling. These processing steps take about 3-5 seconds for each glass plate image. Generally speaking, however, mokkan regions occupy less than a half of the whole image, and background colour of most of glass plate images is almost the same in various images. Hence, we have made improvements to speed up and increase accuracy in this work.

Firstly, we just use a default threshold to binarize a glass plate image and detect mokkan regions. In this way, we shorten the binarization time and reduce the processing area. Furthermore, we employed HSL filter and YCbCr filter in order to detect mokkan fragments more effectively. By using these filters, we can adjust the HSL or YCbCr range to detect the background colour of the glass plate image instead of taking time to calculate threshold value in global thresholding methods. The filters are not only faster but also more effective than the global thresholding methods in our experiments on glass plate images. After the mokkan fragment detection, as the same with the previous method, connected component labelling and contour tracking are performed to get the boundary of fragments, small connected components are deleted, and curve points on the boundaries are reduced by the algorithm of Douglas and Peucker (1973). The process is shown in Figure 4.

![Figure 4. Automatic zone-definition process.](image2)

With described improvements in mokkan region detection and mokkan fragment detection, the automatic zone-definition processing performs and returns the result immediately. Figure 5(b) is the interface for verification. Although parameters of each processing are configured with default values experimentally obtained, users can adjust these parameters to get the best performance while confirming the result of the operation through this interface.

![Figure 5. (a) Image processing for reading mokkans form and (b) Automatic zone-definition form.](image3)
3.4 Constructed mokkan images database for reference on the Web

With the spread of the Internet, publication of electronic information has become common in recent years. Even in the historical studies, historical documents and databases have been also published on the Web. Nara National Research Institute for Cultural Properties has published a mokkan dictionary of about 7,900 mokkans where approximately 57,000 characters are written. In addition, there is a plan to publish the mokkan fragments which are unearthed from the Heijyo 440th excavation. We have accumulated over 3,700 glass plate images of about 37,000 mokkan fragments and constructed the mokkan fragment images database. Then, we have built a homepage as shown in Figure 6 to enable users to access to this database from the internet. For these fragments, their excavation information has been input and zones are defined but mokkan information including character information shown in Figure 2(a) remains to be annotated by archaeologists.

![Figure 6. Website to access the mokkan images database.](image)

4. Summary and Future Work

In this paper, we introduced a support system for archaeologists to accumulate, annotate and retrieve images of mokkans. It provides a set of tools to annotate, export data, store in database, search, print, etc. We made improvements to the system in its interface and automatic zone-definition method to reduce time and effort of experts. We also incorporated into this system the image processing methods for archaeologists to read scripts on mokkans. Moreover, we made mokkan images available through Web and shared by many experts and people.

In this work, we have accumulated about 37,000 images of mokkan fragments from the Heijyo 440th excavation by using this system. In fact, they are broken pieces or shavings and handwritten characters are unreadable in more than 90% of them. These fragment images must be electronically assembled so that characters are more readable. Therefore, our next plan is to construct a tool for people to be able to enjoy assembling of mokkan fragment images in the future.

Acknowledgments

This work is being supported by the Grant-in-Aid for Scientific Research (S)-20222002.

References


