

# Design and Implementation of Digital Jikin using Smartphone Application

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## ABSTRACT

Due to the recent advances of IT industry, many companies and institutions have been used electronic documents rather than original paper copies. However, the characteristic of electronic document allows it to be readily damaged from proscribed copying, counterfeit, and falsification. These can cause the serious security problems for electronic documents. Conventional security methods for digital documents involve adding a separated image or marker, but these methods can reduce the readability of document. Therefore, we proposed a digital Jikin (Korean traditional stamp) which is normally used to identify the source or author of a document in asia. The proposed digital Jikin can preserve the readability of electronic document while protecting the document from proscribed copying, counterfeit, or falsification using image processing approach. In this paper, a digital Jikin application is designed and implemented under android platform and it converts the critical information of document onto the digital Jikin. The proposed digital Jikin contains important information in the boundary of Jikin not only about the author of documents or source, but also keywords, number of images, and many more. Therefore, the authenticity of document or whether the document has been altered or not by other person can be evaluated by the server. The proposed digital Jikin can be sent to a server through the wireless networks and can be stored using PHP and MySQL. We believe that the proposed method can offer the better and simple solution for strengthening the security of electronic document.

✉ keyword : Digital Certification, Digital Jikin, Image Processing, Data security, Android application, Smartphone

## 1. Introduction

Due to the recent advances of computer, most institutions have started to prefer electronic documents over traditional paper copies due to an ease of storage and management, and it causes the security problems of these electronic documents to become an issue. Electronic documents make the authorization process to be simple by reducing the number of steps required for approval. Despite of this advantage, the lack of security through the usage of electronic documents is a substantial issue, as the accessibility of electronic documents allows the formation of counterfeit, falsified and duplicated documents easier. Normal documents in asia usually contain Jikin to identify the source of the document.

This paper presents a digital Jikin that will substantially solve security issues that are listed above.



(Fig. 1) Korea traditional stamp(Jikin)

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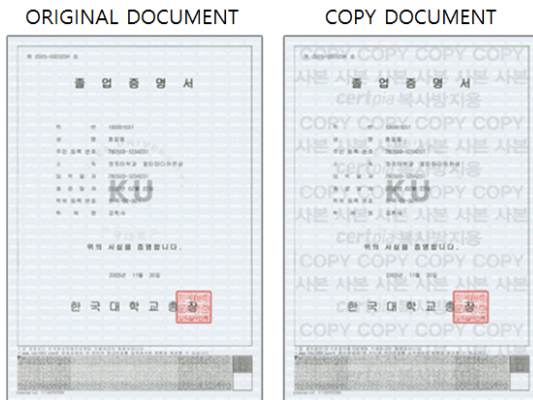
☆ This paper is an extension and amendment to the recommendation of the best paper of the ICONI 2016 Conference.

The digital Jikin is able to distinguish whether or not an electronic document has been counterfeited, falsified, or duplicated through the analyzation of the color on the border

lines of digital Jikin. The proposed image processing based method can store the critical document related information such as creation date, author, and title with data encryption in digital Jikin. We believe that the proposed method can improve the security of electronic documents.

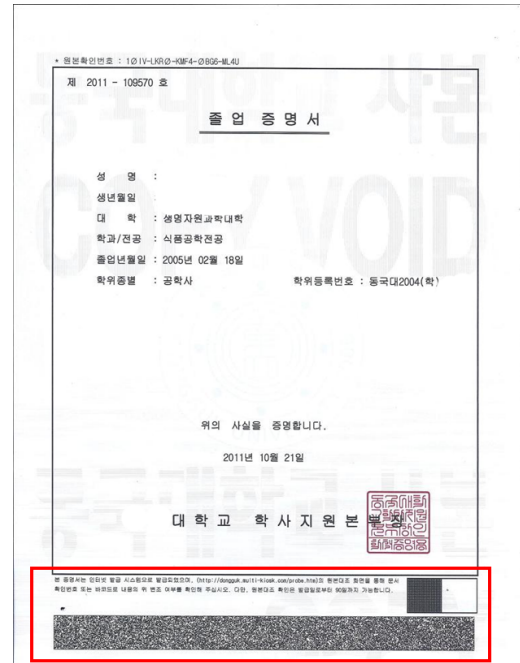
## 2. Traditional Security Solution for Electronic Documents

DRM(Digital Rights Management), DLP(Data Loss Prevention), and SBC(Server Based Contents) are all common existing solutions for security of electronic documents, but DRM is used the most.



(Fig. 2) DRM based on watermarking [1-3]

DRM technology only allows users with permission to access digital contents. Due to this fact, it is very popular among major companies and government services. With DRM, documents are protected by setting a password on the document so it can neither be copied nor deleted. Therefore, documents can be defenseless when the password is decoded by hackers. DRM combined with digital watermarking has the ability to protect illegal copies since it can trace illegal dissemination which is shown in Fig. 2. However, a special watermarking or a separate copy protection mark should be printed or added, which is shown in Fig. 3 and may pose as an issue.



(Fig. 3) Existing of special watermarking on official document

But this watermarking method is not user friendly approach because it loses readability or needs extra technology that is complicated. Therefore, in order to create a more user friendly security system, this paper proposes digital Jikin that can be used on common documents. Documents with Jikin will be stored and protected after encrypting the critical information such as author, creation date, and the title information onto the Korean traditional Jikin.

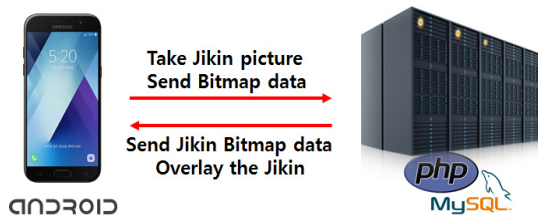
After the physical picture of Jikin on an existing document is recognized through the application, the new, protected digital Jikin will automatically be created. This process uses the smartphone camera so that typical users could readily scan the Jikin, which is very simple, yet powerful, compared to the DRM method.

The created digital Jikin can be used naturally because it is made with a real Jikin on paper document. Also, unlike existing methods, the advantage of the digital Jikin is that general users cannot distinguish the secret code since necessary information is encrypted and stored using fine

colors which are hard to distinguish on border lines of the Jikin. The proposed digital Jikin can hide the critical data in the border of edge without additional complicated watermarking and these information are not easy to be detected by naked eye because small color alterations are used. In addition, the proposed digital Jikin can be automatically created with smartphone.

### 3. Digital Jikin Application Environments

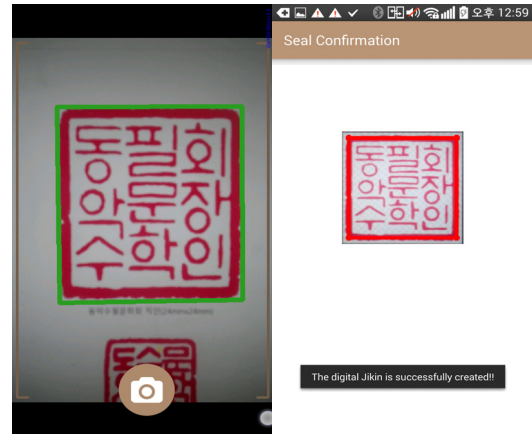
The application developed on this paper is operated on the Google Android Operating System. In general, Google Android applications are developed with java program language. Also, the developed application converts the existing real Jikin to digital Jikin by image recognition by image processing technology. To implement this, OpenCV, an open source library, is used for image processing. As shown in Fig. 4, the application developed in this research takes the picture of Jikin and transmits the photographed data to the server through PHP and MySQL.



(Fig. 4) Communication between android and PHP/MySQL

Then the server creates the digital Jikin with critical information and overlays on the original document and sends the results to the application. When the application is started, users can easily create a digital Jikin by clicking a button. Fig. 5 shows the result of digital Jikin creation application developed through this research.

In order to create a digital Jikin, the actual Jikin on normal paper must be photographed. The photographed Jikin is transformed by the application into the electronic version



(Fig. 5) Snapshot of implemented digital Jikin application



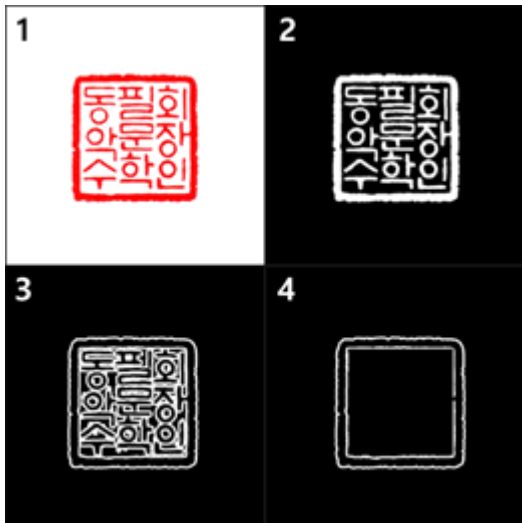
(Fig. 6) Creation process for digital document

of Jikin with image processing routine. However, the digital Jikin must be embedded into the digital document to be used. The proposed application provides a convenient feature that automatically combines the digital Jikin and the electronic document image when the user takes a picture of the document.

In Android, there is a canvas where drawings and shapes can be drawn. Using this canvas, it is possible to place the photographed document underneath the digital Jikin as shown in Fig. 6. Through this, it is anticipated that users would be exposed to a method that allows them to easily utilize and create the protected digital documents.

In order to utilize this process, the Jikin or the document must be detected from the photographed image. The

traditional Jikin and document has the quadrangle form, therefore the proposed method detects quadrangles from the photographed image. The proposed algorithm is described in Fig. 7.

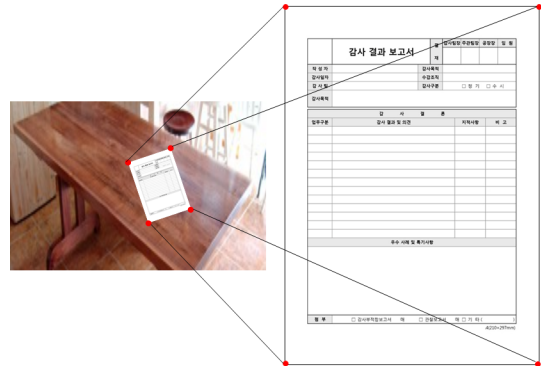


(Fig. 7) Process for Jikin detection

First, the photographed picture must be changed to Grayscale color using openCV's cvCvtColor function. The processed image contains a lot of noise therefore the cvSmooth function is used to smoothly out the image which is then transformed into binary data using cvThreshold. The result image is the second figure which is shown in Fig. 7 [4-9].

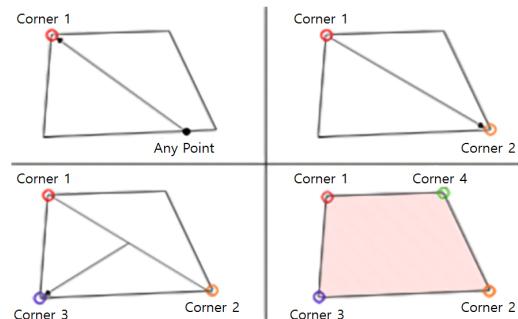
Next, in order to find the square in the image, the cvCanny function is used to detect the edges in the image. Finally, when there is a total of four corners on the detected edge, it is determined that the shape was a square. The fourth image in Fig. 7 represents the stage of the completed square detection process using the proposed method. The biggest square is distinguished as the outer edges of the Jikin and stored for further use. However, the photographed Jikin and photographed document can be tilted or distorted depending on the angle the user takes the photo.

Fig. 8 shows how the distorted or tilted image can be recovered. Image warping, when an image is stretched or tilted in order to transform the image, is used to substantiate the recovery process of the tilted or distorted image.



(Fig. 8) Image warping[10-12]

We transformed the photographed image to fit the most widely used A4 paper size in South Korea. As shown in Fig. 8, the photographed document's edge is detected and transformed according to the standard A4 size. However, before this process it is necessary to find the four corners of the image.



(Fig. 9) Detection process of square corners

It is possible to detect the four corners of square using the method which is shown in Fig. 9[13-15]. First, a temporary point is selected and the point furthest from the temporary point is saved as corner 1. Using the same approach, the point the furthest from corner 1 is saved as corner 2, and the point the furthest from both corner 1 and corner 2 is saved as corner 3. Thus it is possible to detect the 3 corners of square. The final corner is detected using the shape's surface area.

The 3 corners that have already been detected and one of possible points are used to calculate the surface area which is shown in Fig. 10. The fourth corner can be determined

from some of possible points which returns the largest surface area. We utilize the following equation to calculate the surface area of square. The process described above is how a document was able to be processed before being transformed by warping as shown in Fig. 8.

$$A = \frac{1}{2}(x_1y_2 - x_2y_1 + x_2y_3 - x_3y_2 + \dots + x_ny_1 - x_1y_n)$$

$$= \frac{1}{2}\{x_1(y_2 - y_n) + x_2(y_3 - y_1) + \dots + x_n(y_1 - y_{n-1})\}$$

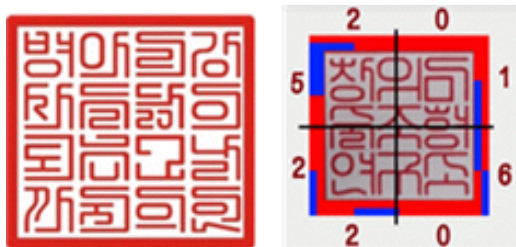
(Fig. 10) Equation for surface area

## 4. Information Encryption in the Digital Jikin

The proposed digital Jikin is able to keep the record of creation date, author, title, and so on. Fig. 11 demonstrates how the creation date is encrypted into the digital Jikin. Information for the creation date can be divided into year (four digits), month (two digits), and day (two digits) resulting in a total of eight digits that represent the creation date of document in binary. For example, in order to express numbers from 0 to 9 in the computer world, we need to use at least 4 bits as expressed in Table 1.

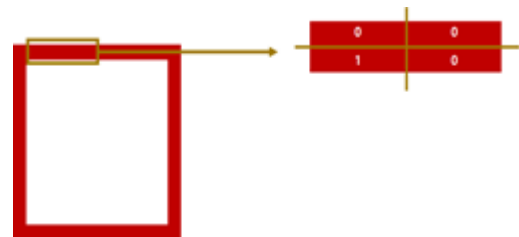
(Table 1) 0~9 Binary number

Number	Binary	Number	Binary
0	0000	5	0101
1	0001	6	0110
2	0010	7	0111
3	0011	8	1000
4	0100	9	1001



(Fig. 11) Encryption of information for creation date of document

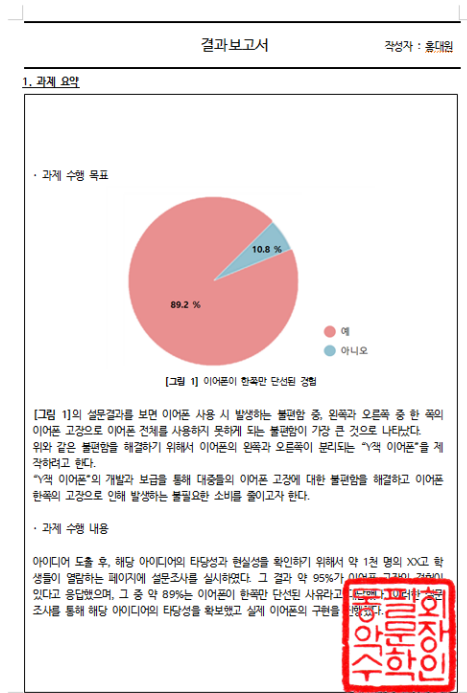
Therefore, in order to store creation date information, it is essential to be able to save 8 different 4 bits of size data. In the digital Jikin, 1 bit is either 0 or 1, therefore in order to save the creation date information, the digital Jikin must be created like the right drawing of Fig. 11. The outer border of the square must be divided into two column, with two row on each side, creating space for the year, month, day data that requires eight digits. The actual encrypted Jikin is almost impossible to distinguish to the naked eye due to the fact that two colors with small alterations are used. However, computers are able to easily detect these difference. The right image in Fig. 11 is an example of an encrypted seal with the creation date information of February 25th, 2016. In this example, easily comparable colors are used in order to help readers understand how the binary system implemented into the application works. However, the actual application is much like Fig. 12. Color is differentiated by the miniscule difference in the pixel value in each region has through the computer.



(Fig. 12) Encryption of the creation date information

Fig. 12 represents the right image in Fig. 11 after the effects of the suggested color change in this paper. This allows the encryption of digital Jikin to exist without users being able to notice. The magnified portion of Fig. 12 represents 2, as the data is encrypted as 0010, with each digit saved in the divided outer border of the digital Jikin. When the data value is 0, the RGB value is represented as (255, 0, 0), and when the data value is 1, the RGB value is represented as (255, 10, 10), which makes the difference in color practically non-existent to the naked eye. In Fig. 12, only the creation date information has been encrypted, however, using the same method of recording the documents contents, it is anticipated that the application is able to stop counterfeit, falsification and duplication.





(Fig. 13) Example of digital Jikin

For example, when a pie graph is included into the electronic document as shown in Fig. 13, then we can conceal the major portion of pie graph information such as the ratio of graph, and it is able to evaluate the legitimacy of the electronic document. Furthermore, critical sentence or keywords in the electronic document can be encrypted in digital Jikin and then it can be used to determine whether the electronic document is legit or not, as well.

## 5. Conclusions

Since an electronic document is more comfortable for storage, management, and authorization, a traditional paper is rapidly moved into an electronic document. However, the digital document inherently imposes the problems of proscribed copying, counterfeit, and falsification. The proposed method can readily conceal critical information of electronic document in the border of digital Jikin using image processing technology thus it can robustly protect the forgery of document. Since the digital Jikin utilizes the

sophisticated color alternation, it is almost impossible to detect the difference with the naked eye.

We believe that the proposed digital Jikin can detect the critical data without any additional complicated approaches such as DRM, DLP, or SBC and these information are not readily to be detected. In addition, the proposed digital Jikin can be automatically created with smartphone. For the further study, when the take the photo under complex environments such as lighting or shadow, we need to compensate these effects for better performance of proposed method.

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