Fingerprint/Palmprint Matching Identification Technology

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Abstract

NEC has long been carrying out R&D for improving the accuracy of automated fingerprint/palmprint matching technology. This paper introduces the technology for eliminating noise information from an image in which unnecessary fingerprints or patterns are superimposed as noise disturbance, which often causes a problem with latent prints collected at crime scenes. The development of this technology is expected to enable high-accuracy latent print matching operations while reducing the human work input.

Keywords

fingerprint, palmprint, automated matching
image enhancement, noise elimination

1. Introduction

NEC is about to commemorate its fortieth anniversary since starting research into automated fingerprint matching. In the past, we have achieved several significant results, particularly in the R&D of image pre-processing technology for improving matching accuracy. As a result, we have scored highest in several benchmark tests for fingerprint matching related processing that were conducted at the National Institute of Standards and Technology (NIST) in the U.S.

Fingerprints and palmprints are used to determine if an arrested suspected criminal is the same person as one who has already been registered in previous criminal records or to provide the results of comparisons between the fingerprints and palmprints of a suspect with those left at a crime scene as evidence. However, the images of the fingerprints and palmprints left at crime scenes are often corrupted by diverse superimposed noise. Therefore, when matching fingerprint or palmprint data using a computer, it has become extremely important to extract from an image in which noise is superimposed only the information on the target fingerprint or palmprint.

Below, we introduce a technology for eliminating curved stripe pattern noise from fingerprint/palmprint images on which it is superimposed.

Since the parts that can be touched by humans are generally limited, it is highly probable that multiple fingerprints will be superimposed on a single location. This technology is useful for dealing with such situations and has been made possible for the first time thanks to our rich experience in the processing of target fingerprint/palmprint images as well as to our advanced technical ability regarding image processing.

2. Noise Elimination Technology for Fingerprint/Palmprint Image Matching

A fingerprint is composed of multiple ridges in curved stripe patterns and has long been used in crime investigations thanks to its characteristics, such as its life-long permanence and uniqueness. Particularly, matching by using latent prints left at crime scenes is a very effective means of crime investigations. Although many crime investigation agencies have recently introduced computer-based fingerprint matching systems, identification by investigators and the automation of identification have often been achieved only with difficulty. This is because the latent print images are often of low quality containing much noise disturbance.

Images of latent prints include those in which the ridges of several fingerprints are superimposed and those in which the curved stripe patterns have been disturbed by rubbing. When one of the fingerprints in a fingerprint-superimposed image is defined as the processing target, any other fingerprints can be regarded as background noise. Hereafter, such background noise in the curved stripe pattern will be referred to as curved stripe pattern noise, which will also include characters or rubbing forming a curved stripe pattern. The curved stripe pattern noise is similar to the processing target fingerprint in that it also has a curved stripe pattern. As a result, it has been dif-

ficult to extract only the target fingerprint information from superimposed fingerprints or to eliminate unnecessary fingerprints or rubbing forming the curved stripe patterns regarded as noise without deteriorating the target fingerprint.

Development of an algorithm for enhancement of the target curved stripe pattern

In this section, we will introduce the effects of the developed ridge enhancement algorithm by means of a simulation using an image in which three fingerprints are superimposed. **Fig. 1** shows the image of the fingerprint that is the target in this particular enhancement processing. **Fig. 2** and **Fig. 3** show the images of the fingerprints that constitute respectively the first and second noise disturbances. **Fig. 4** shows the simulated image collected at the actual crime scene, in which the three fingerprints are superimposed. The objective of this enhancement processing is therefore how to reproduce Fig. 1 from Fig. 4.

Several processing methods have been proposed to solve this problem. There is for example the method of using local 2D Fourier transforms to analyze the sequence of the line intervals and directions of the stripe patterns. In order to leave only those components in an indicated direction, a method has been proposed as shown in **Fig. 5** for manually indicating in advance the approximate direction of ridges in the target image. However, this method is not always capable of proper isolation in cases where the direction of the noise stripe pattern is close to the direction of the ridges of the target fingerprint.

Fig. 1 Target fingerprint image.

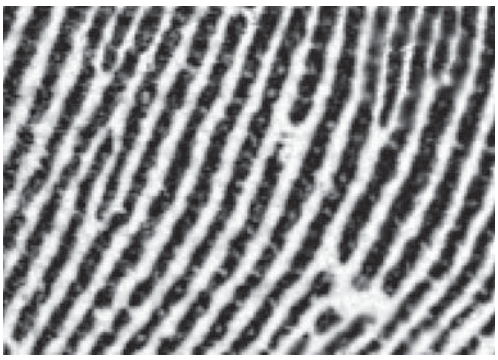

Fig. 2 First noise image.

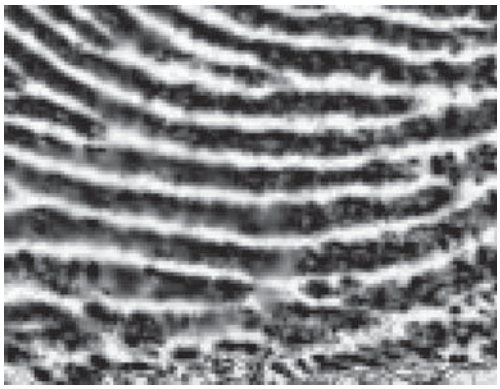

Fig. 3 Second noise image.

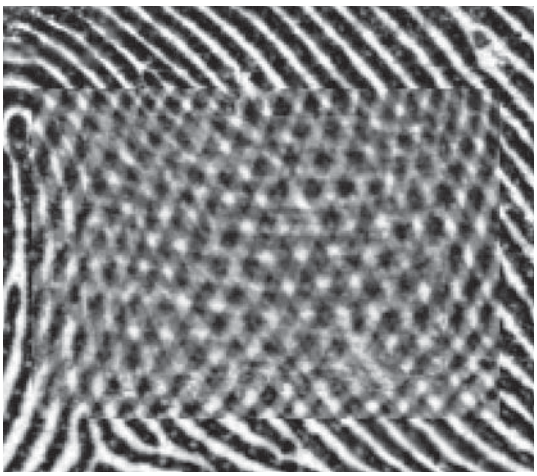

Fig. 4 Noise-superimposed image obtained by overlapping the first and second noise images.

With the newly developed technology, an image in which the ridge information of the target fingerprint is indicated manually is created as shown in Fig. 5 and an image in which the local ridge direction of each section of the target image is then estimated from the manually created image as shown in **Fig. 6** . After that, an image estimating the local ridge direction is created from the noise-superimposed image, without the indication on the ridge direction of the target fingerprint as shown in Fig. 5. The difference in the local ridge direction of each section is compared between this image and the image in Fig. 6 and an image eliminating noise is created based on pre-determined rules. Since two kinds of noise patterns are superimposed in this example, the image eliminating noise is again subjected to extraction of the ridge direction of each section. The extracted ridge direction is compared for a second time with the image in Fig. 6 and the final image eliminating the noise is created based on the pre-determined rules.

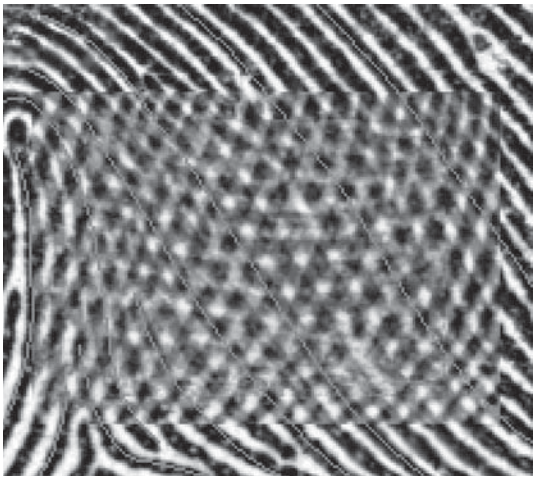

Fig. 5 Indication of the ridge directions of a target fingerprint in a noise-superimposed image.

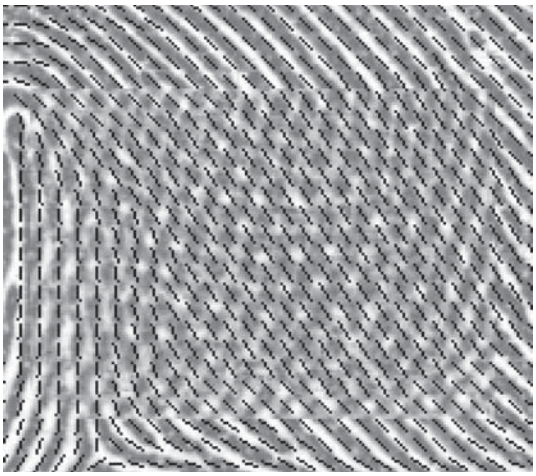

Fig. 6 Result of local ridge direction estimation of a noise-superimposed image.

Fig. 7 Result of enhancement of the target image in a noise-superimposed image.

Fig. 7 shows the final result obtained after two noise elimination operations as described above. It shows that the target image shown in Fig. 1 is reproduced fairly precisely.

In the above, we mentioned that noise elimination is performed based on pre-determined rules. However, this technique does not apply 2D Fourier transform processing according to the local ridge direction in each section, as does the traditional technique. On the other hand, this technique attempts to eliminate the noise directly by interpreting that the gray values of the image along the target ridge direction are varied significantly by superimposition of noise, while they should in fact be almost constant if the ridges belong to the target image. Because of this principle, this technique is effective with noise that can be regarded as forming a stripe pattern with respect to the target fingerprint image.

3. Actual Case Verifying the Noise Elimination Technique

The following figures show a case in which this technique is applied to an actual noise-superimposed image. In the im-

age in **Fig. 8** , noise that may be attributable to another fingerprint is superimposed on the top right area and characters noise is superimposed in the lower right area. When the target ridge direction was indicated for this image as shown in **Fig. 9** , the final noise-eliminated enhanced image became as shown in **Fig. 10** .

As proven in the above, this technique makes it possible to easily extract accurate ridge information from an image in which noise is superimposed. While the previous technique

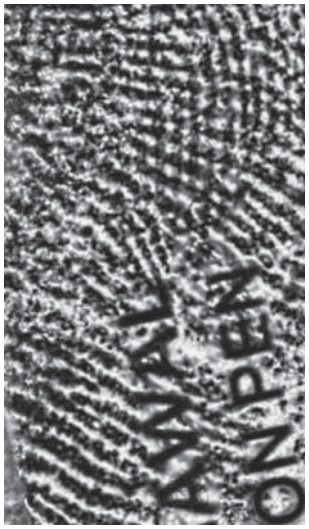

Fig. 8 Actual characteristics of noise-superimposed image.

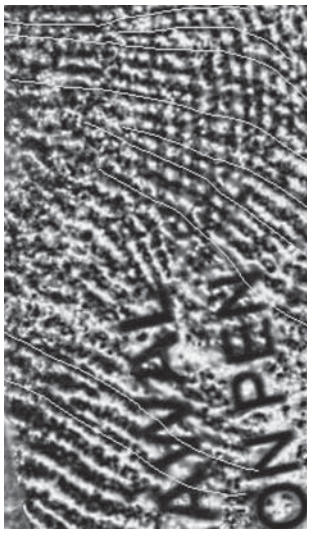

Fig. 9 Indication of target ridge direction.

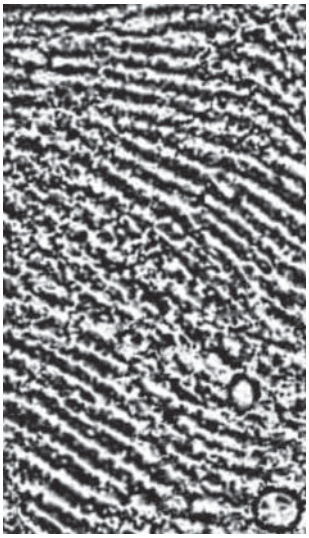

Fig. 10 Result of noise elimination.

necessitates very complicated and difficult work in monitoring an image in which noise is superimposed, the new technique can extract the ridge information of a noise-eliminated image by simply indicating a suggested direction of a target ridge in a relatively simple and approximate manner.

Furthermore, when the enhanced image obtained by noise elimination is of a relatively high quality, it is possible to extract information from the enhanced image for automated matching by computer. With image matching of latent fingerprints/palmprints it has hitherto been quite difficult to extract information that can be used in automated matching with a computer because the images are often unclear and with relatively high noise intensities. In contrast, the proposed technique makes it possible to computerize much of the work required for extracting information for use in matching.

4. Future Deployment

With the noise-eliminated enhanced image processing technology for fingerprint/palmprint images introduced above, it is still necessary to indicate the target ridge directions manually, but automation of this operation is anticipated for the future. Once this is made possible, the result will not only offer practical utilization at crime scenes but an automated matching technique with a high noise elimination capability will also be much more effectively applied in large-scale crime investiga-

tions. The counterterrorist measures that are currently attracting international attention will also benefit significantly from the proposed technical enhancements.

5. Conclusion

At NEC we have long been conducting R&D for improving the accuracy of fingerprint/palmprint matching. Although the fingerprint/palmprint matching technology is an established technology it is actually in the process of continuing evolution. The newly developed technique for noise elimination and enhancement that we introduced in this paper is only a part of such evolution. Additionally, we are also conducting R&D aimed at enhancing the method of extracting information for use in matching and for improving matching accuracy by combining matching methods with various characteristics. We intend to continue our R&D in the future so that we may contribute effectively to the realization of a safe and secure world.

Reference

1) "NEC Fingerprint Matching Technology Ranked No. 1 by the NIST," NEC Press Release, April 16, 2009. (Results shown from the Evaluation of Latent Fingerprint Technologies do not constitute endorsement of any particular system by the U.S. Government.)

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