A New Imaging System with a Stand-type Image Scanner “Blinkscan BS20”

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OVERVIEW: Progress in information network technology has made it easy to use various kinds of image contents via networks and on PCs (personal computers). In this information environment, the stand-type image scanner “Blinkscan,” is a useful tool because it can convert various objects such as business documents and color copies into electronic data by using non-contact reading. Moreover, it can scan an A4 color page in only about 3 seconds, and capture image data at high resolution, best for optical character readers (OCRs). In Japan, this scanner is mainly used in banking for so-called image workflow systems. However, it is suitable for a wide range of business applications such as web contents production or printing and publishing, where work must be finished within a short period of time, and for presentations as a document camera together with a PC and a projector.

INTRODUCTION

HITACHI has been developing a desk-top scanner since 1997. At that time, typical image capturing devices were flat-bed scanners or scanners with a sheet feeder. These scanners could not be used for counter transactions in banks. One reason was that it took too much time to scan forms and checks; another reason was that forms and checks got jammed. In 1999, Hitachi first shipped a stand-type black-and-white scanner operating at a high speed without jamming the paper. This scanner has since been used by many financial institutions. With progress in network technology and in order to respond to the demand for producing color copies at a high speed, we developed “Blinkscan BS20” in 2001.

The main features of the scanner are below:

(1) The scanning time is about 3 seconds for an A4 page, which is the highest speed for this type of color scanners. Its operation is very simple and easy — just place a page on the reading board and the scanner will scan it.

Fig. 1— Stand-type Image Scanner.
Blinkscan was developed to enable high-speed scanning at high resolution and easy scanner operation.

TABLE 1. Blinkscan Basic Specifications
Blinkscan demonstrates high-speed scanning, reading an A4 200-dpi, and black-and-white page in 2 seconds.

Item	Specification
Maximum document size	297 × 216 mm
Resolution	200/240/300/400 dpi
Image data stream	Black and white/gray scale/color
Lighting	500 to 2,300 lx (natural light)
Scanning speed (A4, 200 dpi)	Black and white: approx. 2 s Color: approx. 3 s
Device interface	PCI
Device driver	TWAIN32
Dimensions	340 (W) × 330 (D) × 550 (H) mm

PCI: peripheral component interconnect

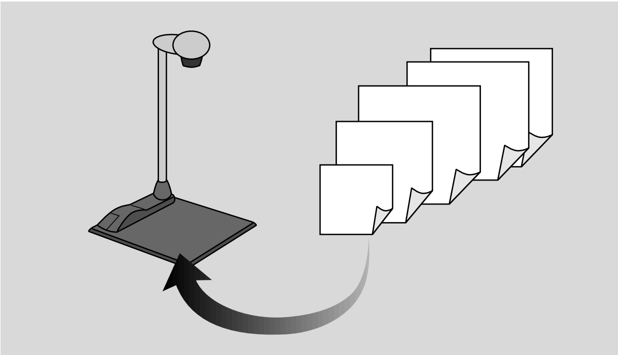


Fig. 2— Scanner Applications.
The scanner can be used to scan various objects, such as business documents, photographs, and small 3-D objects because it supports and enables non-contact reading.

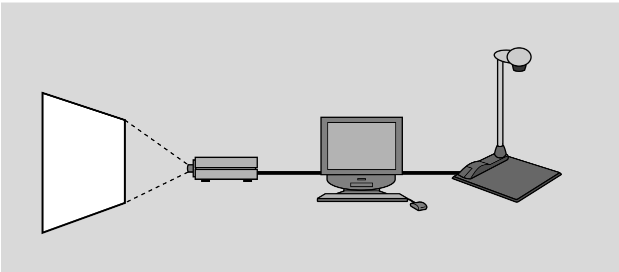


Fig. 3— Applications of Blinkscan as a Document Camera.
With a PC and a projector, Blinkscan can be used as a document camera. Documents placed on the reading table can be projected on to the screen.

(2) Due to the use of the most advanced sub-pixel image processing technology, image data with approximately 12 million pixels can be captured. This high-resolution image capability allows for various uses of OCR, including color-document reading and document-camera applications.

(3) The scanner can be used for a wide range of documents. Blinkscan does not "touch" the paper, so documents of various sizes, thicknesses, and quality can be scanned. There is no paper jamming.

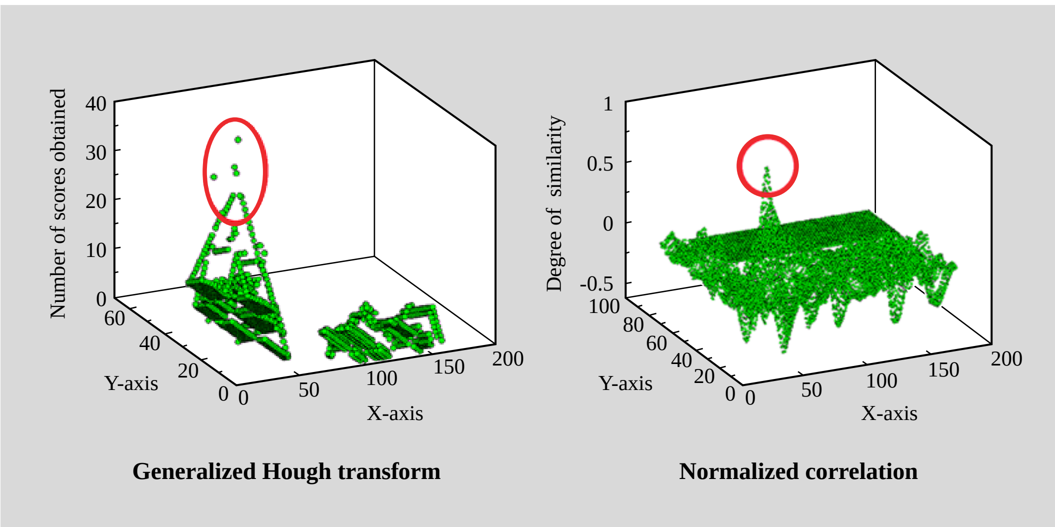
HIGH-QUALITY IMAGES

The scanner has a CCD (charge coupled device) area sensor for image acquisition. At the time of the development, 1.5-Mpixel CCD was the norm for such area sensors and we had to develop a new technique for scanning A4 pages at a resolution of 300 dpi (about 9 million pixels). We achieved this by capturing images of low resolution image data many times from different positions and restructuring them into one synthesized image.

The difference in resolution due to the variation in optical system parts and the accuracy of assembly of optical systems were adjusted by image processing of expansion or reduction. Positioning markers were installed in four corners of the document table for this adjustment. Then, the problem was how to detect these positioning markers with a sufficient degree of accuracy. Because these markers are also used to adjust the image brightness and the standard of picture logging, detecting these markers is very important. However, it is difficult to always detect these markers correctly in an open light environment, which means that mark detection had to be improved. Hereafter, we describe our mark detection method.

The methods based on generalized Hough transform and normalized correlation to extract a certain form out of a picture are well-known. Generalized Hough transform is suitable for extracting

Fig. 4— Mark-detection Results in Generalized Hough Transform and Normalized Correlation. Normalized correlation was used because it enables high accuracy in mark detection.



a specific form from a picture with a lot of noise. Normalized correlation can be used to extract a specific form even when the brightness of the target picture is unstable.

Let coordinates with the largest number of scores obtained be the coordinates of a marker in generalized Hough transform. Likewise let coordinates with the highest degree of similarity be the coordinates of a mark in normalized correlation.

The results for each method are shown in Fig. 4. In generalized Hough transform there is some variation in the number of scores obtained. This is because the straight-line edge of the reference point was not adjusted and consequently the scores are distributed, because the mark was slightly tilted. In contrast, there is little variation with the high degree of similarity in normalized correlation. Therefore, we used normalized correlation for mark detection.

The detected mark coordinates (x, y) are shown in Fig. 5 by the red lines. The gap between the detected mark coordinates and the center of the mark is about 1 to 2 pixels, and it could be detected with a very high degree of precision.

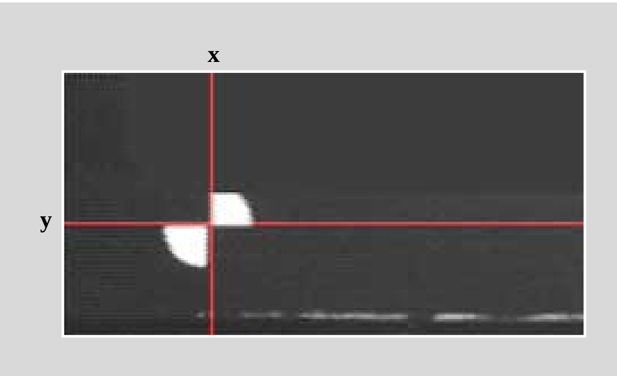


Fig. 5— Mark Coordinates Detection Result.
The detection error was less than 1-2 pixels.

MODEL APPLICATION

Paper forms are still commonly used for various transactions such as utility bill payment, tax payment, and bank order processing. Paper forms have their own advantages, however transactions are now processed by computer systems using electronic data instead of paper forms.

Here we describe an image-based workflow system we developed. According to the conditions specified in bank BPR (business process reengineering), the image workflow system must minimize clerical operations of branch offices and centralize expert knowledgeable staff. Fig. 6 shows the system configuration and a teller station equipped with our scanner.

Banking transaction forms, such as those used for money transfer and utility bills, are scanned and recognized by the teller station. The electronic image data and recognized text data are transmitted to the operation center with skilled operators and authorized specialists. Each piece of data is processed by the staff

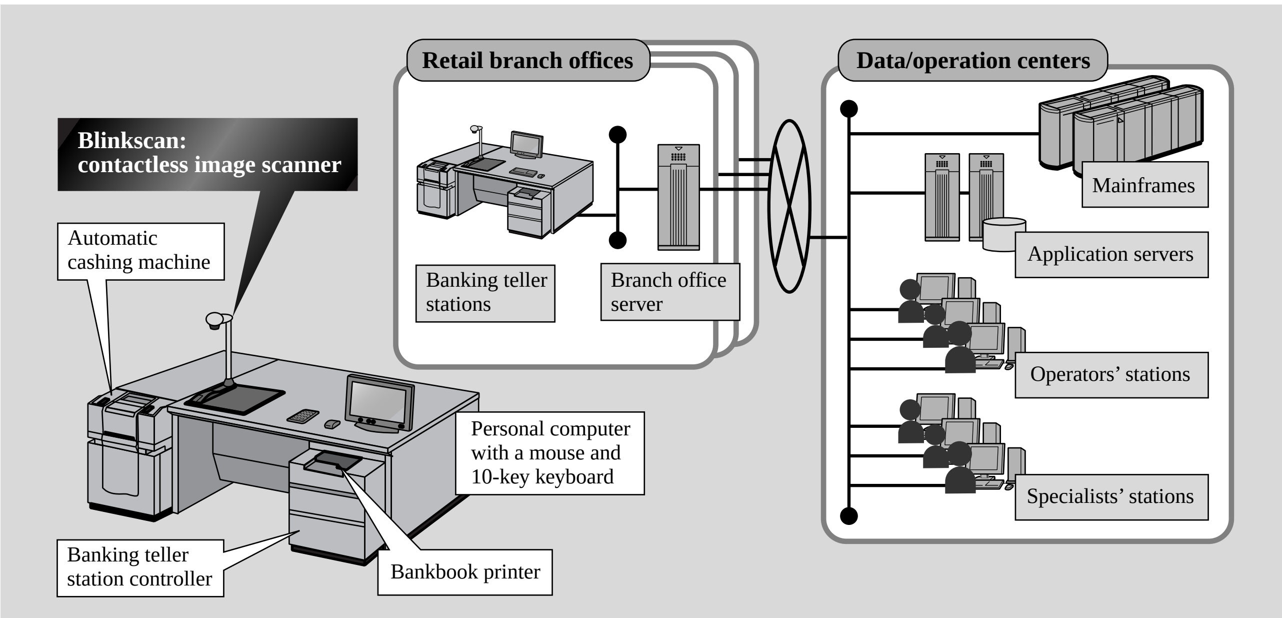


Fig. 6— Image Workflow System for Banks.
The proposed workflow largely reduces bank tellers' workload.

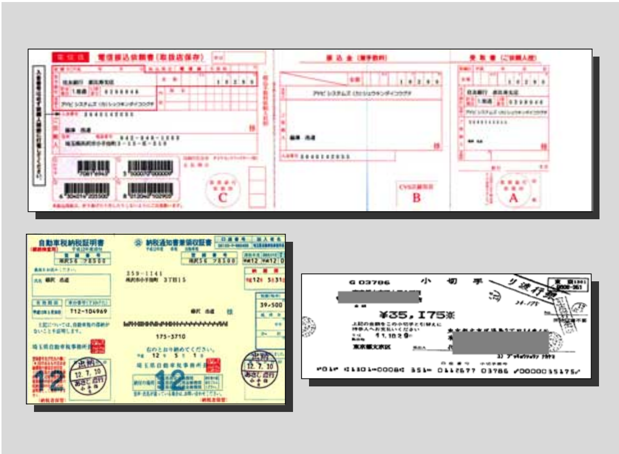


Fig. 7— Format Examples.
A variety of formats can be scanned.

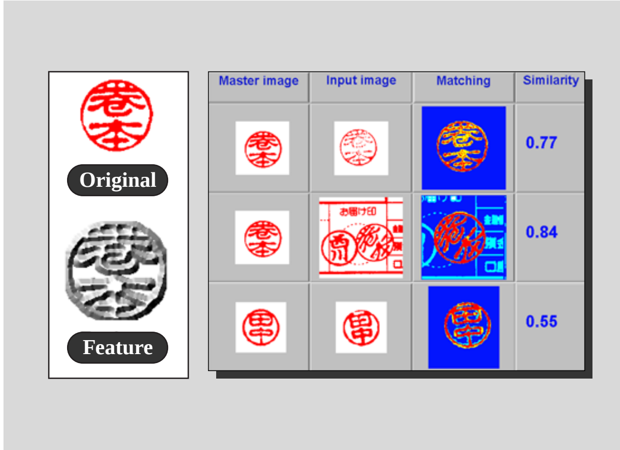


Fig. 9— Seal Similarity Measurement and Verification.
Input image is translated and rotated so that it matches the master image.

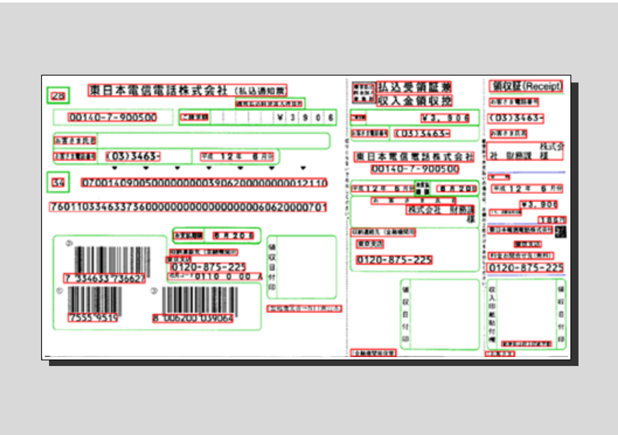


Fig. 8— Various Features of a Format can be Recognized.
Different features such as the size and location of forms are used to identify the type of format used.

TABLE 2. Recognition Software Functions
Recognition software has various functions that enable scanning business-related forms.

Functions	Explanation
Form identification	Identification of forms by analyzing the frame structure and character strings
Character recognition	Handwritten/machine-printed digits, alphabets, symbols, kanji fonts; OCR fonts; Bank check digits
Lexical verification	Best-match word search by consulting a lexicon database
Seal verification	Pattern matching of an input seal image with pre-registered seals
Barcode recognition	Automatic location of barcodes JAN code, NW-7, CODE37
Image processing	Affine transformation Compression/decompression

and is finally transferred to the account processing mainframe. Examples of forms including bank cheques are shown in Fig. 7.

Recognition software recognizes various elements of the form and identifies the type of form. This form identification automatically activates an appropriate application and queues the data in an appropriate workflow. The form identification capability identifies title character strings and various features of the form and the OCR function interprets field image data into computer text data for data entry (see Fig. 8).

Seal image handling is an inevitable part of banking transactions in Japan. The recognition software has a seal verification function based on similarity measuring. The scanner captures the seal image on the form and the recognition software enables seal verification at all branch offices due to the use of an electronic master seal image database, which simplifies seal image comparison.

Seal image similarity is measured based on the use of a multi-dimensional model. This technology provides precise measuring criteria, comparing images pixel by pixel. The software also has support functions for manually comparing seal images. Fig. 9 shows the process of seal image measuring and seal verification.

RECOGNITION SOFTWARE

To integrate the recognition function or the seal image handling capability with application software, functions described in Table 2 are used. The application interface structure of the recognition software is shown in Fig. 10.

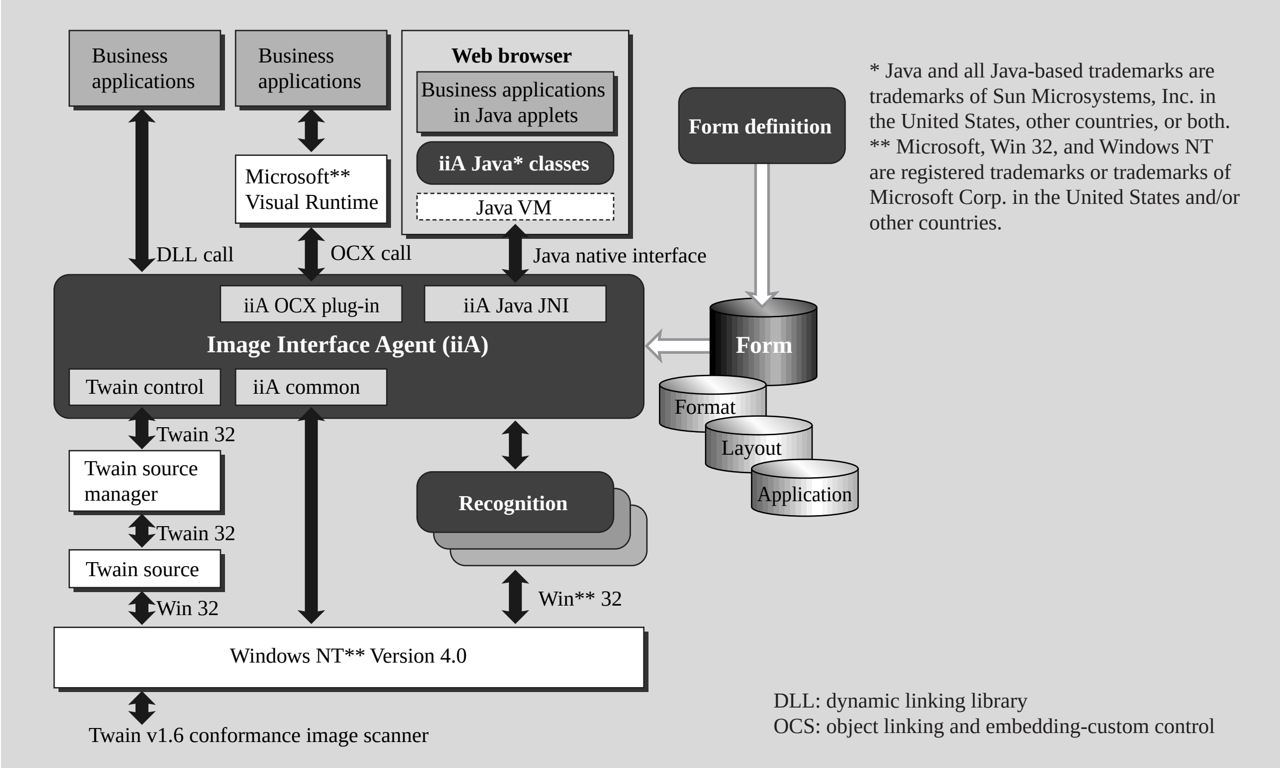


Fig. 10— Application Interface.
Image interface agent (iiA) enables flexible software design.

CONCLUSIONS

We developed a stand-type scanner, Blinkscan, that enables high-speed scan at high resolution and simple operation. It supports various business related applications image including those for banks.

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