

# iJITinOffice: Desktop Environment Enabling Integration of Paper and Electronic Documents

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## ABSTRACT

A desktop environment called “iJITinOffice” is discussed. Annotated information written on the printout can be accessible via the original electronic file, and can be shared. Furthermore, electronic files can be retrieved by providing paper document information such as when printed. This prototype system is implemented using Anoto technology and now in trial operation in our lab.

**ACM Classification:** H5.2 [Information interfaces and presentation]: User Interfaces. - Graphical user interfaces.

**General terms:** Documentation, Design, Human Factors,

**Keywords:** Annotation, handwriting, document management, digital pen

## INTRODUCTION

In current offices, the number of the electronic documents is increasing, because office workers write documents using PC and download documents from the internet. For example, most of papers and technical reports which researchers write are electronic files. On the other hand, the paper consumption in offices is increasing [4]. It is because paper is convenient for browsing documents, and for writing down the ideas in brain-storming. Actually, meeting materials are distributed as paper documents in many meetings in Japanese offices.

Even in the company cited as a successful case of paperless office in the literature, paper documents are often used in the collaborative task such as design review process in development [4]. That is, paper is more suitable for expressing the ideas during the discussion than an electronic document.

Handwriting on the meeting materials is the record of the collaboration process itself, and is regarded as the organizational memory. This kind of knowledge should be crucial management resources for the enterprises. But it is left unused in the filing cabinet.

Our motivation in this research is to enable us to utilize the information left unused on paper documents by digitizing handwritten annotations, and by linking them to the corresponding electronic documents. And we try to implement a PC desktop environment where we can browse, retrieve, and handle both electronic documents and paper document information seamlessly.

Guimbretière proposed the Paper Augmented Digital Document (PADD), which is the digital document that can be manipulated either in the digital world or in the paper world [2]. PADD focuses on how to bring the handwriting information on the paper document back to the digital document. That is, the paper document and the electronic file are just the expression of the digital document, and they should be always synchronized.

In case of document management in PC, it is not always effective that the handwriting information on the paper document is reflected on the digital document automatically. We think paper document and electronic document should be just linked with each other not synchronized for PC desktop environment. Users don't want the electronic file in their PC to be modified forcibly by the handwritten annotation on the print out of the file.

We contribute iJITinOffice, a PC desktop environment which enables to integrate paper document information with electronic document information. When we use iJITinOffice, handwriting information on the printout can be accessible via the original electronic file, and can be shared among the persons the printouts were distributed to. Furthermore, electronic file can be retrieved by providing paper document information such as when printed. “iJIT” stands for the concept “Information Just-in-Time.” Our prototype is embodiment of this concept [3].

## IJIT\_IN\_OFFICE DESKTOP ENVIRONMENT

### Integration of paper document & electronic document

A paper document is generated by printing an electronic document on PC. The electronic document could be modified and another paper document could be printed out. In this case, printed contents on each paper document should be different. But two paper documents information is need to be linked because both are printed from the single electronic document. We designed the document information as combination of electronic document and paper document information which corresponds to each paper document.

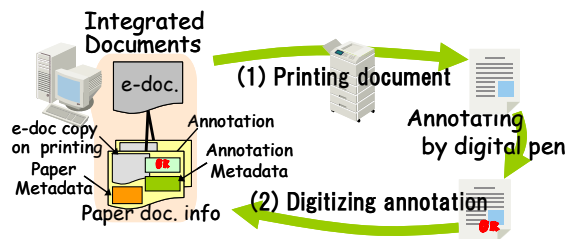


Figure 1: Data structure of Integrated Documents

### Data structure for expressing document information

Based on the consideration above, the data structure of a paper document is designed as shown in Fig. 1.

#### (1) Electronic document on printing

In case the user tries to re-print the paper document or to edit the printed version of the electronic document, the electronic document on printing should be stored.

#### (2) Paper document metadata

Physical layout information such as n pages in one piece of paper should be necessary for assigning handwritten strokes to the appropriate position on the paper document. Information like when the paper document was printed, or who printed should be kept for retrieving the document.

#### (3) Annotation information

This should be stored in vector format, not image format.

#### (4) Annotation Metadata

Information such as who annotated, or when annotated is also useful for retrieving the document.

## PROTOTYPE IMPLEMENTATION

### Overall architecture

We have implemented iJITinOffice prototype. For digitizing handwriting and for printing documents in order for annotation to be digitized, Anoto technology [1] is used. This prototype enables us to print paper documents with dotted pattern from any application format file without any special manipulation, to digitize handwriting by digital pen, and to store the digitized handwriting associated with the application file. The prototype is on server-client architecture. Anoto's Paper Lookup Service is running on the server. DBMS for the printed documents with annotations is also running on the server. User accesses the server through the client program for printing, digitizing handwriting, and browsing the documents.

## Client functions

### Viewing the linkage between paper and e-docs

Users can view the correspondence between electric documents and the printed paper documents in the expanded Explorer window (Fig. 2 (a)).

### Browsing documents

Paper document with annotations can be displayed as a PDF file (Fig. 2(b)).

### Retrieving documents

Electric documents and printed paper documents can be retrieved by the metadata of the paper document and the annotations (Fig. 2(c)). This retrieval is regarded based on the human memory about that person's action like writing comments during some meeting.

### Sharing documents and security policy

Paper documents with annotation can be shared by creating a special file called "iJIT file," and send the file via e-mail. Users who are provided with the physical paper are allowed to access the paper document information.

## DISCUSSION

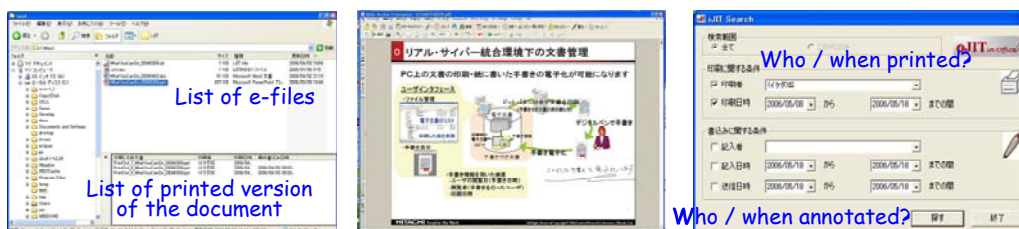
This prototype started the trial operation inside our lab this spring. More than 100 users participate in this trial at the moment. Participants' reaction is pretty good, especially in that they can share the paper document information with handwritten annotations without scanning sheets of paper. Some of them often use this prototype for proofreading of technical paper.

## CONCLUSION AND FUTURE WORK

iJITinOffice, a PC desktop environment which enables to integrate electronic document information with printed paper document information are proposed. Further analysis of users' behavior would be conducted in our lab.

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(a) Paper, e-doc link viewer

(b) Paper image browser

(c) Document retrieval interface

Figure 2: User interfaces of iJITinOffice