Document Tracking and Collaboration Support using RFID

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Abstract: Even today paper documents are extensively used in offices. This paper presents an application that extends the classical office desk system with an RFID based document tracking techniques. We describe an application that identifies the specific location of paper documents on an office desk to associate this information to related process information in a cooperation support system.

1 Introduction

Paper is still a major medium of communication in all office environments. It was widely believed that in the future office, paper will disappear or its use will be very limited. Electronic document versions were supposed to replace physical documents [SH01]. But the use of paper documents is increasing, especially in the form of mails and print outs [ZN04]. People feel comfortable with paper while reading long articles, to annotate them and also for record keeping purposes. Paper documents help people to work in a more convenient way as compared to electronic documents [SH01].

The system presented in this paper provides users with a proactive real time environment that automatically retrieves and displays digital information associated with any real object, e.g. documents. In the proposed system, we have used an RFID based location sensing system to detect and locate the position of documents on a desk. The combination of the application with a cooperative workspace system enables the linking of paper documents and files to the electronic counterparts or into the overall cooperation and process context. Different search mechanisms enable users to locate a document with its complete location history.

2 Approaches to Augmented Office Environments

The ubiquitous computing approach is used by a number of researchers for the automation of offices and digital desks [W93]. Radio Frequency Identification (RFID) is utilized as a promising technology for object tracking, while barcode technologies where applied previously [PK96], [PF02]. Xerox Research Center Europe [AC03] proposed a system that is able to identify user's print job among a bulk of printed documents with the help of RFID. In addition it is able to inform user about similar print jobs received

from other users. The Xerox system requires an extensive infrastructure such as WLAN, Bluetooth and Active RFID setup. It requires that all people are equipped with PDA or some mobile device which can receive and send information.

Based on the importance of paper documents in today's offices [SM04] considers paper documents as first-class citizen. Accordingly, they present a new universal enterprise document model that considers paper documents as the key object The Atira system [ZN04] is a sensor-rich environment which supports interaction, physically and virtually, with documents. Its aim is the identification of a user and a document context, based on the interpretation of simultaneous occurrences of documents and users at a certain location. NOSTOS [BL03] illustrates the application of RFID for document identification in a health care environment. Documents, tagged with RFID labels, enable users to retrieve the electronic counterpart of medication documents from a database at different locations in the healthcare environment.

All these approaches try to combine the identity of paper documents with computer applications utilizing RFID technologies. Our approach adds to this research presenting a system that enables users to link documents to cooperative processes and existing shared document workspaces. We do not require the user to adapt to a new document model or new working modes such as the approach of [SM04]. Further it supports users to retrieve the current location of paper documents on a user's desk as well as the location history.

3 The Context Desk System

The "Context Desk System" (CDS) was built keeping in mind the real environment of an office especially the scenario of placing and interacting with documents on a desk-top. We narrowed down the digital office idea to a desk-top level and realized an environment which is responsive to physical documents located on different locations at the table.

The system is based on the following components: RFID Tags attached to the documents; a set of RFID Readers installed below the desktop surface to sense the RFID Tags; a multiplexer hardware that controls the different RFID sensors/antennas; the CDS Client that is connected to the multiplexer unit using a serial interface. As RFID sensors short transmission range readers at a frequency of 13.56 MHz are used with passive RFID tags to realize a cost effective solution. RFID tags are attached to most documents or files on the table. The tags are as thin as paper and can be used as file stickers. The installed system is capable to detect multiple tags per scan and sensor.

Based on an observation of the user's usage of the table space, 8 RFID sensors have been installed under an L-shaped office desk. The readers cover the complete area of the desktop. Some of these locations represent typical inbox or outbox locations, others represent short term or topic related storage areas. A dedicated are is the location beside the user's computer keyboard. This space normally contains documents or files that are currently in the user's focus. Therefore the CDS client interprets objects located at this space in a specific way to provide the user proactively with background information.

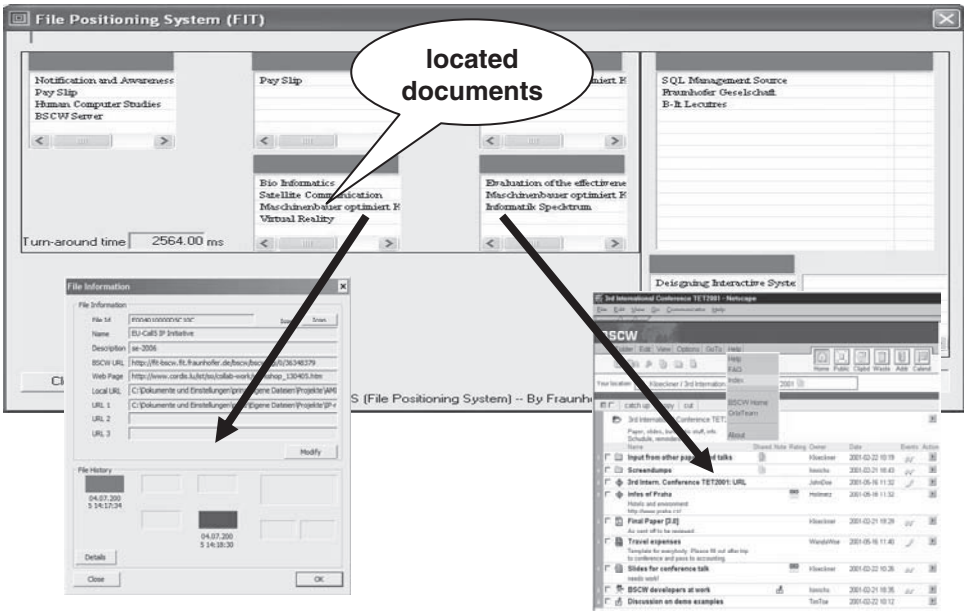

Fig 1: CDS User Interface showing links to the meta- and history-information as well as the associated cooperative workspace

Fig 1 shows the user interface of the CDS client. The 8 text boxes correspond to the location of the RFID readers below the desk surface. The client periodically scans the multiplexer unit for the tag ids. After recognition of an id, the client searches a local XML database for corresponding meta-information. This meta-information consists of a name, a description, and one or more URI (Universal Resource Identifier). In addition deadlines and reminders can be stored for an object. These URI point to background information associated with the identified office object. This can be web-pages, local files or documents, shared workspaces of a groupware system or an email folder. The name of the identified tag is shown in the corresponding text box. If more than one object is located and identified for a place, a list is shown. The user can open the related information that is associated by the URI by a double click on the list entry. A right mouse click opens a window that displays the editable meta-information described above. If the CDS client detects an RFID tag for which no meta-information is available a pop-up window is displayed and the user is requested to provide the necessary meta-information.

A history mechanism is introduced to keep track of document locations. The history database stores the location of recognized documents in combination with a timestamp. This enables the tracking of the different positions of a document on the desk and it helps to put the documents back on their proper positions. The history mechanism can be evaluated after a specific period of time to detect and remove infrequent used documents from the table for archiving purposes. In combination with the search function this feature also enables the user to retrieve the last position of a document on the desk. Often

this information helps users to recognize the last activities they performed on a document. The deadline attribute of the meta-information is used to trigger a reminder. This is indicated by coloring the document name in the corresponding list.

4 Usage Scenario and Initial Experience

The described context desk system is now installed and in use in a regular office since 2 months. During this time it went through several iterations in which additional functionalities like search and history functions have been added. In the meantime most of the relevant files have been tagged and registered by the users. This was also performed iteratively. Whenever a new file folder appeared on the desk it was tagged with an RFID label and registered in the system. In the meantime approximately 20 objects are tagged.

The objects vary from simple wrappers that contain frequently changing documents such as flyers or brochures to project folders and books. In most cases the meta-information associated to these objects link to related information in a shared workspace and virtual project office system. We use BSCW [A99] for our purposes. The advantage of BSCW is that it is fully web-based, thus allowing the addressing of a workspace with a URL. The "real" project folder is then linked to the corresponding virtual project folder in BSCW. This folder contains related information as well as the electronic counterparts to the paper documents. Objects that are independent of a particular process such as text-books are often linked to a web-site, a news-group or a forum. Experiences with use of the system indicate the following two primary advantages: (a) immediate and direct access to related information in the context of an object present at the users desktop; and (b) identification of the location of objects on the desktop

During the daily use the first advantage can be considered as the most important. After a short period of time it became the common behavior of the user to use the CDS client to access electronic information that was related to the documents or file folders that were placed beside the keyboard, i.e. the place where normally the working materials are located. Saving time is the primary advantage here since background information could be accessed by a single mouse click, while it took normally several browsing activities before the right BSCW folder or information was found and opened. Thus the CDS system provided bookmark functionality, by associating electronic bookmarks with real world objects and things. Therefore we have coined the term Thinkmark™ for this.

The identification of object locations on the desktop was also considered useful. However this feature was less used for finding documents. It proved more useful to remember folders that were covered under a pile of other documents. Presenting the folder names in the CSD client brought the tasks associated with these object to mind. Otherwise the user might have forgotten about these tasks until a reorganization of the document pile.

Using the system, lead to new requirements that are currently being realized. In its current version CSD associates objects with electronic information. It became evident that the opposite direction is also practical and feasible: Since many paper documents are

stored and cooperatively developed using BSCW, it often happens that the actual paper document is already out-dated by a new version that has been contributed by another team member. In such a case the CSD can verify the update/version information of the document in BSCW to inform the user that the document located at the desk has been updated by other co-workers in the meantime. This avoids reading out-dated documents. Another aspect is that the reminder function should be combined with the user's calendar or to do list to achieve a better integration with standard office tools.

5 Conclusion

This paper presents a straight-forward solution for the contextualizing of office objects such as documents, file folders or books with background information from the Web or from a groupware system. Experiences with the system indicate that it provides a useful support for the immediate look-up of related working information. The current version does not support the distributed management of the meta-information database. Therefore the next system version will include new functionalities to notify the user about activities of co-workers on the electronic versions of his paper documents and it will also support a distributed client-server solution. This will enable the evaluation of the approach in a multi-user setting.

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