Finding Objects in "Strata Drawer"

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ABSTRACT

Looking for a document in a stack of papers is a difficult job. If the "strata" of the drawer contents is known, then locating will be much easier. Strata Drawer is a camera-enhanced cabinet used for storage. This cabinet has a single, deep drawer equipped with a camera, a depth-sensor and a computer. When a user places an object in the drawer and closes it, a photograph is automatically taken, and the height of the contents is measured by a laser beam. A user can browse pictures of strata in the drawer's contents, with timestamps and height information.

Keywords

Strata Drawer, Digital Decor, ubiquitous computing, smart furniture, drawers.

INTRODUCTION

In the near future, we will be using many single purpose information appliances equipped with ubiquitous, invisible computers [3]. Decor such as furniture, appliances, and other small objects commonly found in homes are a good place to install invisible computers, because they also have single or, at most, a small number of functions, and have familiar, simple operations. Although there are many possibilities for computer augmented decor, or "Digital Decor" [2], we have focused on smart storage application in this paper. Embedded computers in everyday storage decor such as drawers, cabinets, shelves, toy boxes, shoeboxes, and letterboxes, can support the search for items by keeping track of the items placed in the decor and all the salient interaction events associated with those items.

Although taking pictures of cabinet or closet contents is sometimes recommended as the secret of storage mastery, the overhead involved in finding the camera, taking the picture and then storing those pictures in a way that makes them ready for use as a reference is prohibitive. If storage furniture were equipped with a sensor, a camera and an embedded computer to both control the camera and act as picture server, finding objects in the storage could be made much easier. A cupboard equipped with a camera inside the door, or a toy box with a camera under the lid can take a picture of its contents when a user closes the door. By browsing pictures in time sequence, a user could find items even if they are obstructed by objects more recently placed in front (or above) them. If the images captured by the camera are automatically served to the internet, the user will be able to remotely view the contents of two or more of these computer augmented storage and never have to move room to room, or house to office in search of items.

Figure 1: Strata Drawer has a digital camera (*upper center*) and a laser diode (*upper right*) that is used to measure the height of the contents.

Many office workers have stacks of documents on their desk. We always seem to have certain documents that could be discarded but may be required someday, so we keep them on our desk. As a result, document stacks never disappear from our desktops. To find a document in an unordered stack is a difficult job. One approach to this problem is to use a geological cue in the strata of the documents. Since one way that document stacks grow on the desk is in time sequence; we know that we can find older documents in the lower strata. If, in the process of searching for a particular document, we find a related or contemporary document, we can guess the target document is in the nearby strata.

CHI 2003, April 5-10, 2003, Ft. Lauderdale, Florida, USA.
ACM 1-58113-637-4/03/0004

STRATA DRAWER

Strata Drawer, seen in Fig. 1 is our prototype of a camera-enhanced cabinet used for storage. This cabinet measures 64cm high × 49cm wide × 39cm deep, and has a single, deep drawer equipped with a reed switch, halogen lamps, a digital camera (Olympus D-360L with 0.6× wide-angle converter lens), a laser diode, and electronic circuits. These devices are connected to the computer (1GHz Pentium III with Linux OS), which is running two software components; a picture-taking program and a WWW server. The camera is mounted facing downward to take a picture of the contents of the drawer. The computer controls the camera and extracts the captured images through its connection to the serial I/O port [1] . When a user closes the drawer, the program in the computer detects the drawer-close event through the reed switch, turns on the lamps, takes a picture and transfers the picture to the computer. The barrel distortion created by the wide-angle lens is compensated by code in the picture-taking program. Other code in the picture-taking program adjusts the white balance of the picture.

A laser diode is located in the upper right-hand corner of Strata Drawer and projects light diagonally to the lower left-hand corner of the drawer below. A cylindrical lens is placed in front of the laser causing it to project a line of laser light across the contents of the drawer. After taking a picture and turning off the lamps, the program turns on the laser and takes a second picture of the drawer contents illuminated by the laser line. Since the laser beam shines diagonally across the contents of the drawer, the height of the contents is measured as the distance from the edge of the drawer to the line drawn by the laser. The further the line of laser light shown in the second picture is from the left-hand edge of the drawer, the higher the contents in that drawer. The program determines the height by interpolating a pre-measured value, in the accuarcy of about 2mm.

The first picture taken by the camera is placed on the WWW server with a timestamp along with the measured depth information. A dedicated browser for the page has been written in Java and shown in Fig. 2. This browser provides the user with time and depth sliders to navigate the captured images. Since these images are on the WWW, browsing can be done from any computer with access to the Internet.

Strata Drawer has been used in our office for more than two months, to keep a stack of papers that were previously left out on one of the authors' desk. During this period of time Strata Drawer and browser were used with good effect by the author to locate personal documents such as bank statements or product leaflets, without opening the drawer.

Although our application scenario implies an office or SOHO environment, Strata Drawer can be used in everyday life wherever we use drawer cabinets. For example, it can be used in a home to store clothing, and to keep a stack of shirts, pants, and underwear.

[1] http://photopc.sourceforge.net/protocol.html

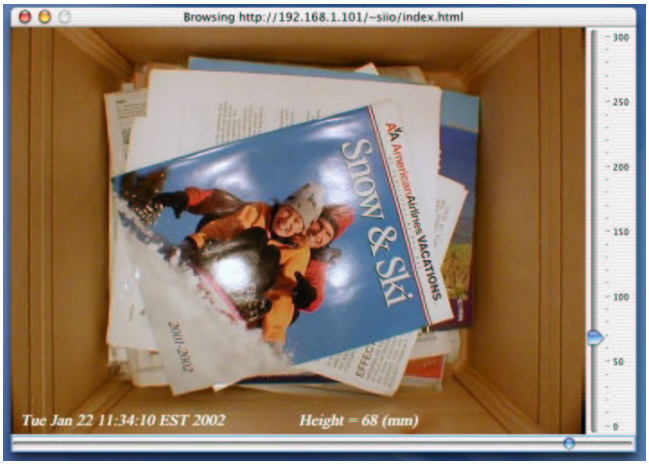

Figure 2: The Strata Drawer browser has time and height sliders (*bottom and right*) to browse through the stack of objects that are in the drawer.

RELATED WORK

There are many possibilities for camera-enhanced drawers. Peek-A-Drawer[2] is a pair of networked drawer chests to provide light weight human communications. HomeBox [1] is a set of drawers designed as a WWW content creation tool for people in the developing countries. Strata Drawer addresses smart storage to support locating task in the drawer.

TouchCounters [4] is a system with storage containers and a shelf. Each container has a display and the shelf has sensors to identify the containers. They can be used to manage the contents efficiently by providing usage information for each container. In addition to the timestamp information, Strata Drawer utilizes imege and height information on the contents.

ACKNOWLEDGEMENTS

We thank Tokyo Electric Power Company (TEPCO) and Uchida Yoko Co., Ltd. whose grants funded this research.

REFERENCES

1. Piper, B. and Hwang, R. R. Y.: The HomeBox: A Web Content Creation Tool for The Developing World. Extended Abstracts of the CHI 2001 (2001) 145–146.

2. Siio, I., J. Rawan,J., and Mynatt, E.: Peek-a-drawer: Communication by furniture. Conference Extended Abstracts of the CHI 2002, (2002) 582–583.

3. Weiser, M.: The Computer for the 21st Century. Scientific American, 265 (3), (1991) 94–104.

4. Yarin, P. and Ishii, Y.: TouchCounters: Designing Interactive Electronic Labels for Physical Containers. Proceedings of the CHI 99 (1999) 362–369.