DrawerFinder: Finding Items in Storage Boxes using Pictures and Visual Markers

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ABSTRACT

We propose a novel search technique called DrawerFinder that helps users find commodities stored in two types of storage boxes (with drawers or lids) on a shelf. First, we attach visual markers inside these storage boxes. When a user opens a box, a camera attached above the shelf detects the visual marker and the system automatically takes a picture. Next, the picture is automatically uploaded to an online database tagged with the box ID. Users can then browse these pictures using a PC or cellular phone equipped with a common web browser. We believe our system helps users find items in boxes efficiently as they can browse both pictures of boxes and the surrounding environment (e.g., who last opened the storage box) quickly.

Author Keywords

Storage box, visual marker, picture, drawer, shelf, Web browser

ACM Classification Keywords

H5.2. Information interfaces and presentation: User Interfaces, Design, Human Factors.

General Terms

Design

INTRODUCTION

Storage boxes are widely used in our daily lives, as they can be used to neatly store many small items. However, people often find it difficult to remember and locate items stored in boxes. Thus, they often search an entire shelf and open many boxes before finding the target item. Classification is a method to avoid these problems; however, it is time consuming to always categorize each item. Even when someone completes the classification, other people often break the rules in shared offices or laboratories. To solve this problem, we propose a novel search technique called DrawerFinder that helps users find commodities stored in boxes.

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DRAWERFINDER

DrawerFinder helps people find commodities in two types of storage boxes (with drawers or lids) on a shelf. Figure 1 shows the basic concept of DrawerFinder. First, we attached visual markers inside the boxes. When a user opens a box, a camera attached above the shelf detects the visual marker and the system automatically takes a picture. Next, the picture is automatically uploaded to an online database tagged with the box ID. Users can then browse these pictures – items in the boxes and the surrounding environment (e.g., who last opened the box) – using a PC or cellular phones equipped with a common web browser. First, we explain the system architecture of DrawerFinder.

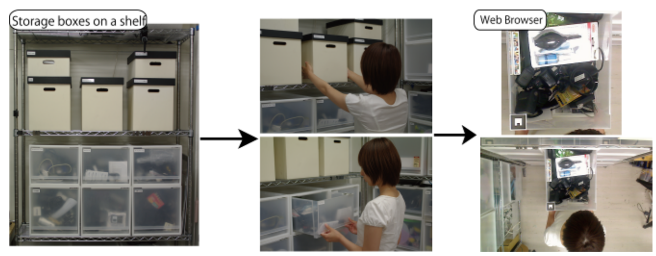

Figure 1. The concept of DrawerFinder. The system automatically captures pictures of storage boxes and helps users browse these pictures – items in the boxes and the surrounding environment – using a common web browser.

System Architecture

DrawerFinder basically consists of two systems: (1)a capture system to automatically take pictures of storage boxes and register them on an online database with simple annotations and (2) a browsing system to help users look through the captured images with a common web browser (Fig. 2). In this paper, we refer to a storage box with a drawer as a "drawer box", and a storage box with a lid as a "lid box" for simplicity.

First, we attached ARToolKit[1] visual markers inside the storage boxes, as shown in Fig. 3. We designed visual markers in the form of 3 x 3 pixels to improve recognition

[1] ARToolKit: a well-known library for developing marker-based AR (Augmented Reality) systems (Available: http://www.hitl.washington.edu/artoolkit)

accuracy[2]. Moreover, we designed markers that were much smaller than the boxes so as not to hinder users from the target finding items: the size of the marker is about 45mm x 45mm, the drawer box is about 315mm x 400mm, and the lid box is about 240mm x 180mm.

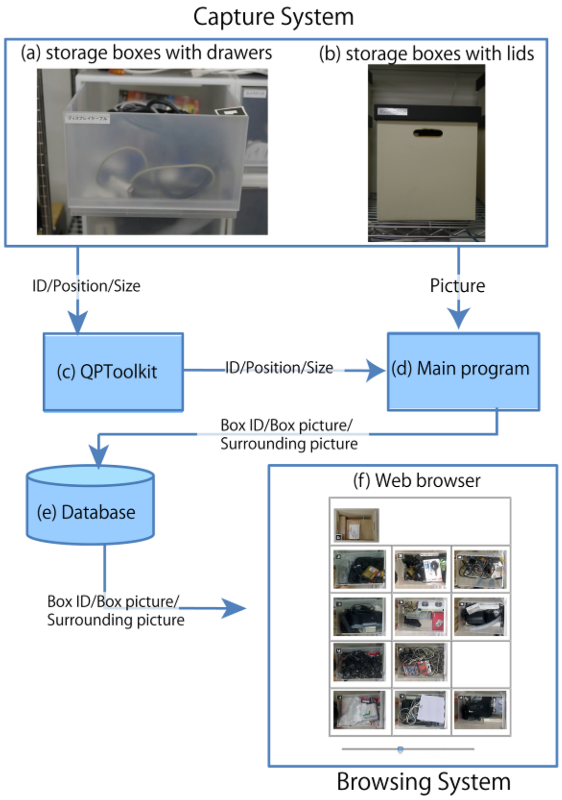

Figure 2. System Architecture of DrawerFinder

Figure 3. Examples of storage boxes and visual markers. We attached ARToolKit visual markers inside drawer boxes (top) and lid boxes (bottom).

[2] ARToolKit allows users to design original markers.

The capture system

The capture system basically consists of storage boxes with visual markers on a shelf, two web cameras (LogiCool Qcam pro for Notebooks) attached above the shelf, and a small PC (Fig. 4). The size of the shelf system is about 120cm x 180cm x 45cm, and contains 3 shelves. We placed 12 drawers on the two lower shelves and 5 boxes on the upper shelves. All visual markers attached to boxes were registered to the system in advance. We also placed the PC on the top shelf and attached web cameras above the top shelf on an arm[3]. We integrated two cameras to perform different tasks simultaneously: (1) detecting the status of the boxes and (2) taking pictures of them. The first camera always monitors the visual markers. When the camera detects a visual marker that maintains its position for several seconds[4], the second camera automatically takes a picture. We used the QPToolkit[5] to detect the ID, position, and size of the marker (Fig. 2c). These data are transmitted to the main program. The main program calculates the position and size of the target box and extracts the picture of the box (the box picture) from the initial picture (the surrounding picture) (Fig. 2d).

The main program then uploads both the box picture and the surrounding picture to an online database with the box ID and timestamp (Fig. 2e). We think the surrounding picture is also useful for users to obtain information on surrounding environment (e.g., who last opened the box). Thus, the system enables users to take pictures of items in boxes and the surrounding environment quickly without any additional operations (Fig. 5).

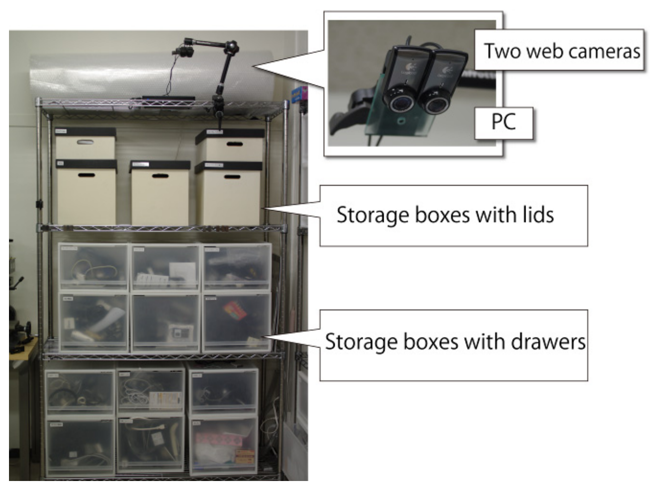

Figure 4. The capture system.

[3] We constructed an acrylic board with a fitting for a tripod and fixed two web cameras on the board. We then connected the board to the arm via the tripod fitting.

[4] Three seconds in the current prototype.

[5] QPToolkit: middleware for detecting ARToolKit markers. (Available: http://kougaku-navi.net/QPToolkit/)

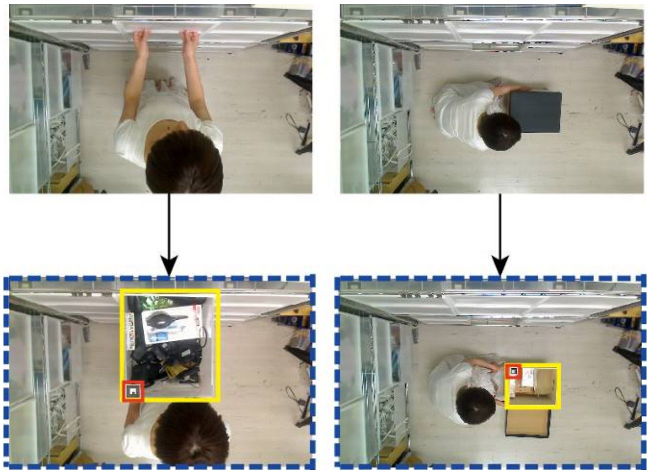

Figure 5. Basic usage of the capture system. Users can take pictures of items in boxes and the surrounding environment quickly without any additional operations.

The browsing system

We developed the browsing system as a web-based application. Users can find items in boxes anywhere by browsing pictures with a common web browser (Fig. 2f). We placed the pictures of boxes on the web page according to their location on the shelf for efficient browsing (Fig. 6, left). Users can browse previous pictures by moving the scroll bar at the bottom of the web page. When a user keeps the cursor on a box picture for a second, the surrounding picture is shown as a translucent image (Fig. 6, right). Thus, our system helps users find items in boxes easily as they can browse both pictures of boxes and the surrounding environment quickly.

Figure 6. The browsing system. Users can browse pictures of boxes using a common web browser. (Left: Box pictures are shown according to their location on the shelf. Right: When a user keeps the cursor on a box picture, the surrounding picture is shown as a translucent image.)

DISCUSSION

Although we have not performed a formal evaluation yet, we have installed the system on a set of storage shelves in our laboratory as shown in Fig. 4.

Here, we discuss the basic performance of the capture system: (1) angle of view, (2) resolution, (3) visual markers, and (4) types of boxes.

First, we verified the angle of view of the cameras when 12 drawer boxes were fully open. We found that the cameras could take pictures of items in all boxes.

Second, we discuss the resolution of the picture. In the current prototype, the resolution of a whole picture is 1600 x 1200 pixels. When the system extracted a picture of a top drawer box, the resolution was about 500 x 600 pixels; whereas the resolution of a bottom drawer box was about 250 x 300 pixels. Thus, the pictures of even the bottom boxes are adequate for brief browsing.

Third, the recognition of the visual markers (45mm x 45mm) appeared to be adequate for any drawer box. Even when a user put a lid box on the floor, the system could stably recognize the visual marker attached inside the box.

Fourth, we discuss the effect of box type. In consideration of usability, we placed drawer boxes on the two shelves below the typical users' line of sight, and placed lid boxes on the upper shelf[6]. When the system took a picture of a drawer box, it could stably extract the box picture from the surrounding picture as the direction and position of the visual marker were kept almost constant. Moreover, the system could stably capture the appearance of users as most users stood in front of the drawers when they removed or replaced items. Meanwhile, when a user found items in a lid box, the direction and position of the visual marker often varied from those of the user as she/he placed the box on the floor. Moreover, her/his body sometimes obscured part of the box. Thus, the system sometimes failed to capture some of the items in lid boxes.

Next, we discuss the browsing system. When a user could not find a target item in a box, she/he often found the last person who had used the box from the surrounding picture and asked the person for the item. Thus, the browsing system helps users find items in boxes efficiently using both pictures of the boxes and the surrounding environment.

RELATED WORKS

There are various techniques to help people find items in the real world: one system employs active RFIDs and ultrasonic position detectors to locate lost items [1]; another system utilizes a wearable camera to record everything

[6] We also had a technical reason: the system required certain distance between the cameras and the drawer boxes to take pictures of items in them without lacking.

around a user [2]; and a third system attaches human detectors and speakers to objects so that then react to the sound of approaching users [3]. However, these systems are not suited for practical use in daily life as they require special devices, tedious setup processes, or huge costs. In contrast, our system enables users to take pictures of items in boxes and the surrounding environment quickly without any special operations. Users can then find items easily using a common web browser. Moreover, our system is suited for installation in a real-life environment due to its simple and inexpensive configuration: two web cameras, a small PC and common storage boxes with visual markers.

Strata Drawer [4] can automatically take pictures of documents in a drawer with height information. Yet whereas Strata Drawer only focuses on a single drawer, our system can capture items in many storage boxes on a number of shelves.

TouchCounters [5] can detect the status of a drawer and show the frequency of use with a LED matrix display attached to the drawer. However, whereas TouchCounters only focuses on the frequency of use of drawers, our system can take pictures of many storage boxes and helps users find items by use of these pictures.

Smart Filing System [6] provides a combination of digital and physical interfaces to an augmented filing cabinet system. It can manage printed documents in cabinets effectively by utilizing a digital pen and ARToolKot markers. Whereas Smart Filing System is only applied to printed data in cabinets, our system can capture various types and sizes of items in storage boxes.

In an earlier version of the current system, we proposed the BoxFinder [7] system that also helps users find unclassified items stored in boxes. Although DrawerFinder and BoxFinder are based on a similar concept, BoxFinder required users to manually capture pictures of storage boxes. DrawerFinder can automatically take pictures of storage boxes with a camera attached above the shelf. Moreover, it enables users to browse both pictures of boxes and the surrounding environment quickly.

CONCLUSION AND FUTURE WORK

We proposed a novel search technique called DrawerFinder that helps users find commodities stored in boxes on a shelf. DrawerFinder can automatically take pictures of items in storage boxes without the requirement of users to perform any special operations. Users can then browse these pictures using a PC or cellular phones equipped with a common web browser. We believe our system helps users find items in boxes efficiently as they can browse both pictures of boxes and surrounding the environment quickly. We have just started long-term evaluation of DrawerFinder in our laboratory to identify necessary improvements.

ACKNOWLDGEMENT

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