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Dear Christina

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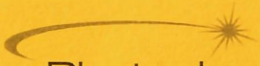
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Andrew G. Tescher
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Low-Cost Asset Tracking using Location-Aware Camera Phones

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ABSTRACT

Maintaining an accurate and up-to-date inventory of one's assets is a labor-intensive, tedious, and costly operation. To ease this difficult but important task, we design and implement a mobile asset tracking system for automatically generating an inventory by snapping photos of the assets with a smartphone. Since smartphones are becoming ubiquitous, construction and deployment of our inventory management solution is simple and cost-effective. Automatic asset recognition is achieved by first segmenting individual assets out of the query photo and then performing bag-of-visual-features (BoVF) image matching on the segmented regions. The smartphone's sensor readings, such as digital compass and accelerometer measurements, can be used to determine the location of each asset, and this location information is stored in the inventory for each recognized asset.

As a special case study, we demonstrate a mobile book tracking system, where users snap photos of books stacked on bookshelves to generate a location-aware book inventory. It is shown that segmenting the book spines is very important for accurate feature-based image matching into a database of book spines. Segmentation also provides the exact orientation of each book spine, so more discriminative upright local features can be employed for improved recognition. This system's mobile client has been implemented for smartphones running the Symbian or Android operating systems. The client enables a user to snap a picture of a bookshelf and to subsequently view the recognized spines in the smartphone's viewfinder. Two different pose estimates, one from BoVF geometric matching and the other from segmentation boundaries, are both utilized to accurately draw the boundary of each spine in the viewfinder for easy visualization. The BoVF representation also allows matching each photo of a bookshelf rack against a photo of the entire bookshelf, and the resulting feature matches are used in conjunction with the smartphone's orientation sensors to determine the exact location of each book.

Keywords: Visual search, location sensing, inventory management

1. INTRODUCTION

Accurately tracking a large set of assets is a difficult, time-consuming task for many people and institutions. Asset inventories are typically maintained by manual updates or deployments of barcode or radio-frequency identification (RFID) technologies. Manual updates are costly in terms of human labor and error-prone. Expensive barcode or RFID systems, on the other hand, may only be affordable to large institutions and require physically attaching a marker to each asset. Given these disadvantages, a more efficient and affordable asset tracking system is desired.

Modern smartphones are equipped with auto-focus cameras, orientation sensors, and high-speed network access. These capabilities of smartphones make them an attractive choice for automated asset tracking. In our asset tracking system, the user simply snaps a few photos with a smartphone of the assets that should be indexed. The pictures are transmitted from the phone to a processing server. On the server, robust image-based features are extracted from the query photos and matched against a large visual database of previously indexed assets or products. Matching these robust features enables automatic identification of assets in the query photos. Subsequently, meta data such as the name, description, price, and manufacturer for each asset can be easily retrieved from the Internet and transferred into the user's inventory database. When the smartphone receives the response from the server, the recognized assets can also be highlighted in the phone's viewfinder. Suppose

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