

3D Image Browsing on Mobile Devices

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Abstract—We present an intuitive user interface for the exploration of images on mobile multi-touch devices. Our interface uses a novel cylindrical 3D visualization of visually sorted images as well as touch gestures and tilting operations to support mobile users in interactive browsing of images by providing convenient navigation/interaction and intuitive visualization capabilities.

Keywords—Visual search; image search and browsing; 3D visualization; interaction

I. INTRODUCTION AND RELATED WORK

Many users employ mobile devices, such as smartphones or tablet computers, for capturing pictures and showing personal image collections to friends and colleagues. This quickly leads to personal image collections that contain hundreds or possibly thousands of pictures. Although text-based image search on mobile devices would be very convenient, this is typically not possible in the absence of meaningful keywords, since users frequently refrain from tagging their pictures. Also search based on automatically generated metadata, such as GPS-location or capturing timestamps, is often not possible due to lack of this information for some images. Moreover, search-by-example as proposed for content-based image retrieval [1] is hardly accomplishable for the majority of users as an example image is usually not available. Therefore, as an alternative to ‘direct’ retrieval approaches, as mentioned above, most users simply perform interactive browsing through their image collections in order to visually find the desired image.

Concomitant with the small displays of mobile devices, searching for specific images by browsing through large image collections becomes a tedious task, particularly for mobile devices that provide only simple interfaces for image browsing. For example, the built-in image software of the iPhone uses a grid-like arrangement of thumbnails of images (i.e., a *Storyboard*) that is able to show 20 images at once. Also the image software of the iPad, which provides a 2.8 times larger screen than the iPhone (i.e., 3.5 vs. 9.7 inches), uses a conventional storyboard that shows 35 images at a glance. Interactive search for a specific image in a list of a few hundreds of images therefore results in an inconvenient search process that requires a lot of scrolling, which also makes it hard to compare images located at different parts

in the list. It is also obvious that a 2D storyboard only allows for linear search time, i.e., there is no chance for a user to find an image that is located at the end of the list equally fast as an image in the beginning of the list.

A few earlier projects have explored alternatives to the scrollable grid-based image arrangement for fast browsing of large image collections on small screens. These include RSVP (Rapid Serial Visual Presentation) approaches [2], Treemap layouts for stylus interaction [3], astute scrolling and zooming enhancements for browsing long arrays of images [4], and tilt-based interaction techniques in combination with Fisheye views [5]. But to the best of our knowledge there is no work that has investigated approaches aiming at improving browsing of large image collections on small mobile multi-touch devices (e.g., smartphones and slate devices), which is the objective of our work.

In [6], [7] we have already shown that a cylindrical arrangement of images in 3D space allows to display more images at a glance. Although images in the back are inherently shown at smaller size through 3D perspective projection, users are able to rotate the 3D arrangement of images in order to bring images from the back to the front and inspect them in more detail. Moreover, Torralba et al. [8] show that humans are quite able to recognize the content of images even if they are shown at very small size. This means that a user of the 3D cylinder is able to quickly detect the target image also in the back of the 3D cylinder (i.e., in the end of the list), which is particularly true for situations where a very distinctive image has to be found. Further possible advantages of a 3D cylinder are reported by Christmann et al. [9] who suspect that it might be easier to memorize the location of individual images in a cylindrical arrangement than in a 2D grid.

In this work we demonstrate image browsing on mobile multi-touch devices with a 3D cylindrical arrangement of images, which can show up to a few hundreds of images at a glance, as shown in Figure 1. Users can rotate the cylinder by using touch gestures or the accelerometer integrated in the device. Touch gestures can also be used to zoom in (or out) to specific areas of the cylinder. Moreover, we use an on-the-fly sorting of images according to colors to facilitate visual search since color sorting has been shown to

support more efficient retrieval [10] in comparison to random arrangements.



Figure 1. Mobile image browsing with a 3D cylinder that provides a color-based sorting of images and interaction by multi-touch gestures

II. SORTING BASED ON VISUAL SIMILARITY

Images are sorted by color according to an efficient and intuitive sorting algorithm, that allows for real-time (i.e., on-the-fly) interactivity even on mobile devices. The basic idea is to sort images based on their dominant hue color in the HSV color space. Therefore, we classify pixels of images into a 16-bin hue histogram (each bin represents pixels belonging to a hue range of 22.5 degrees) and use the index of the dominant bin as a basic sorting criteria. To give a more consistent view, images belonging to the same dominant bin are sorted such that the Euclidian distance of an HSV histogram between adjacent images is minimal. Moreover, we perform a special treatment for bright and dark images, these are arranged at the beginning and the end of the list, respectively. The resulting sorted list is directly used for the cylindrical arrangement with a column-major order.

III. 3D CYLINDER WITH MULTI-TOUCH INTERACTION

A user can interact with the 3D arrangement of images by touch gestures. Wiping over the screen rotates the cylinder left or right, whereas pinch gestures allow zoom-in and zoom-out operations that are a convenient way of inspecting the images in more detail. Tapping an image in the cylinder displays it in even more detail behind the cylinder, which is also used as a link to a fullscreen version of that image. Moreover, tilting can also be used to rotate the cylindrical arrangement (horizontal tilt) or switch the vertical perspective of the whole cylinder (vertical tilt).

IV. CONCLUSION AND FUTURE WORK

In this demo we present a user interface for the exploration of images on mobile devices that uses 3D graphics for improved visualization and touch gestures as well as tilting operations for convenient interaction. This novel interface allows both novice and expert users to browse through

images more efficiently. More precisely, (i) it gives a good overview of the collection being browsed, (ii) it provides a similarity-based presentation of images, which has been shown to support more efficient retrieval of images [10], and (iii) it enables users to quickly spot and jump to particular areas (or “popout-images”) in the whole list through 3D visualization. In further work we will perform extensive user studies to compare its effectiveness to the common 2D grid arrangement.

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