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Interactive lens through smartphones for supporting level-of-detailed views in a public display

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Abstract

In this paper, we propose a new approach to providing interactive and collaborative lens among multi-users for supporting level-of-detailed views using smartphones in a public display. In order to provide smartphone-based lens capability, the locations of smartphones are effectively detected and tracked using Kinect, which provides RGB data and depth data (RGB-D). In particular, human skeleton information is extracted from the Kinect 3D depth data to calculate the smartphone location more efficiently and correctly with respect to the public display and to support head tracking for easy target selection and adaptive view generation. The suggested interactive and collaborative lens using smartphones not only can explore local spaces of the shared display but also can provide various kinds of activities such as LOD viewing and collaborative interaction. Implementation results are given to show the advantage and effectiveness of the proposed approach.

Keywords: Smartphone interaction; Kinect; Interactive lens; Head tracking; Shared display; Level-of-detail view generation

1. Introduction

Recently, smartphone has increased the variety of mobile interactions, which provides new possibilities of natural interface and interaction techniques. Despite many advances in smart devices and interaction techniques, most of the devices are inherently limited in terms of their screen size and amount of information they can display and share. Thus, mobile collaboration and interaction is still not supported sufficiently to allow people to have ad-hoc meetings where they cooperatively execute tasks and manipulate shared information through their smartphones [1–5].

Over the last several years, public displays or shared displays are installed in urban environments such as museums, kiosk terminals and media facades. Personal mobile devices have been identified as promising remote controllers for enabling the interaction with digital contents for public displays, and several respective mobile techniques have been introduced so far by academia and industry [1].

Many research works have attempted to bridge the gap to support natural interactions between smart devices and shared display(s). Early work tried to augment smart devices of limited capabilities with sensing or communication capabilities such as remote controller [3,5]. However, this approach is hard to effectively provide visual information on smart devices to multi-users. To overcome this limitation and support the interaction between smartphones and shared displays, it is necessary to provide visually-controlled interaction, in particular. Some researchers tried to provide access to local information in a public space by tracking the position of a mobile device so that it could be physically moved around to see different parts of the shared space [6,7]. However, they attached sensors on mobile devices to track the relative and local positions, which is cumbersome and not effective [4]. One intuitive and appealing interaction concept is markerless magic lens interaction through a touch-based smartphone [2]. Similar to mobile augmented reality, the user may target a smartphone at the distant screen and observe this real-world scene captured by the camera of the smartphone. Through the key feature detection and analysis of the captured image, touches on the smartphone display can be mapped to the

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corresponding positions on the large display and related actions can be triggered. However, it is almost difficult to target local areas with similar key features as shown in Fig. 1. Moreover, little research work has dealt with how to effectively support visually controlled views such as interactive lens to support individual and cooperative interactions in a shared display.

While some technologies and applications have been developed to support interactions in a shared space using smartphones among collocated users, smartphones have provided little support for local and shared interactions [4]. One of the important issues between shared displays and smartphones is how to seamlessly support interactions between them [8–10]. Another issue to deal with is the possibility of supporting LOD views among multi-users who are involved in a meeting room or large display. To synchronize local exploration between the public display and smartphones, it is necessary to effectively detect local positions of smartphones with respect to each other and to the shared environment. Then, the system should provide a specific and local view to an individual user according to the role and preference [4,7].

This paper presents an interactive and collaborative lens using smartphones for co-located and collaborative interactions in a shared display as shown in Fig. 2. The proposed approach enables for users to interact with digital contents using smartphone-based lens in a public display by spatially tracking multiple smartphones using a depth camera, Kinect, which provides RGB data as well as depth data (RGB-D). In particular, human skeleton information is extracted from the Kinect 3D depth data to more correctly and efficiently calculate the smartphone location and support head tracking. The head tracking is used to support target selection and adaptive view generation. The suggested interactive and collaborative lens using smartphones not only can explore local spaces of the shared display but also can provide various kinds of activities such as level-of-detailed viewing, collaborative interaction, spare-aware interactions, and design review. Since the proposed approach detects the relative and local positions and orientations of smartphones without attaching any sensors, it provides very effective local space exploration and collaborative interaction. We will show the effectiveness and advantage of the proposed approach by demonstrating several implementation results.

Fig. 1. An image with similar or same key features (a map for Gyeongbokgung Palace in Korea).

2. Overview of the proposed approach

The proposed approach can make it easy to interact with a shared display by spatially tracking multiple smartphones with a depth camera as shown in Fig. 3. An initial digital model or multimedia information is registered in a shared display and its functional model is also registered if needed. Based on these models, participants can perform interactive lens tasks and collaborative activities using their smartphones. The local position and orientation of the smartphone with respect to the share space is detected using a depth camera, Kinect™ [11]. In particular, human skeleton information is extracted from the Kinect 3D depth data and is analyzed to detect smartphones, which not only can minimize the possibility of wrong detection of smartphones but also can support head tracking-based adaptive view generation, which is one of the inherent problems of previous approaches based on RGB-D data. Since the location of the smartphone lies on the hand region of the skeleton, this analysis of the skeleton can remove expensive and error-prone image processing. Note that the location of each smartphone has a 3D coordinate in the 3D grid in front of the shared display. After detecting smartphones, the system generates a local space for each smartphone that can play a main role for providing different level-of-detailed views depending on the user's preference and role. Then, the analysis of the head-tracking is used to provide more intuitive and adaptive interactive lens capability such as adaptive viewing and target pointing.

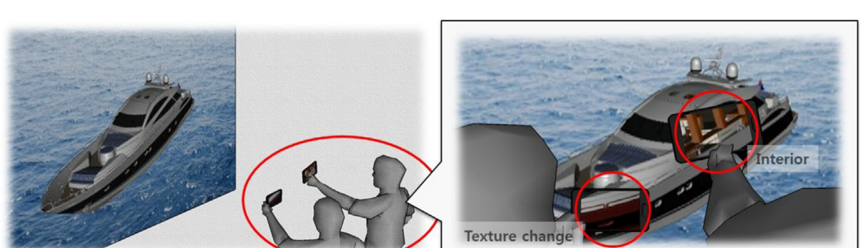

Fig. 2. Conceptual sketch of the proposed approach: local space exploration and different level-of-detailed viewing using smartphone-based interactive lens.