Happy Measure: Augmented Reality for Mobile Virtual Furnishing

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ABSTRACT

The authors present a vision based augmented reality system called Happy Measure to facilitate the measurement, 3D modeling, and visualization of furniture and other objects using a smartphone or mobile device equipped with a camera. They also study the concomitant interaction metaphors that enable interactive 3D model capture and manipulation in augmented environments. The proposed system allows for interactive measurement of an object’s size and the creation of primitive based 3D models from a single photograph. The appearance of the furniture (color textured model) is captured by the system using the underlying (or multiple) images taken by the user. This allows the user to capture textured 3D models of furniture or other objects and manipulate them virtually for visualization purposes. The authors compare two interaction metaphors used to capture 3D textured models of object to ensure easy interaction while still obtaining accurate measurements in a user test. Results suggest that one is superior in terms of measurement accuracy and also subjective user experience as it allows for continuous touch interaction on the whole screen. Virtually placing a modeled object in another location is another aspect of the presented system and the authors explore a novel interaction paradigm to perform this task along with initial user tests.

Keywords: Augmented Reality, Camera Calibration, Image Based Rendering, Mobile Interaction, Visual Metrology

INTRODUCTION

Increasing power of mobile devices and smartphones has significantly contributed to the progress of augmented reality (AR) applications becoming mobile. The first ever mobile AR system, called The Columbia Touring Machine (Feiner, MacIntyre, Hollerer, & Webster, 1997), had to use a wearable laptop together with GPS and Orientation sensors housed in a backpack. In comparison, current day mobile and hand-held devices such as smartphones and tablet PCs
contain similar sensors and computing power and are capable of much the same, if not more.

**Mobile Augmented Reality**

In general, mobile AR applications can be classified as being applicable globally at any location in the world, or being local to the current position of the user within a local coordinate frame. Globally relevant (applicable) AR applications usually depend on GPS based location and orientation together with a known 3D model of the world around them to determine what the user is looking at. Many mobile AR systems ignore the three dimensional nature of the world around the user while providing information at the horizon (e.g., www.layar.com/). In such applications, there is no precise registration of the user’s view and the surrounding 3D world. As a consequence it is impossible to augment the world with objects that are scaled in proportion to the user’s position and context in their surroundings.

On the other hand most local AR applications make use of 2D markers (M. Fiala, 2005; Hirokazu Kato & Billinghurst, 1999; Wagner, Reitmayr, Mulloni, Drummond, & Schmalstieg, 2008) to visually localize the user in a local coordinate frame rather than GPS. The marker thus provides the required registration of the captured image (view) and the surrounding 3D world. As a consequence a much better localization (pose) of the viewer is obtained together with potentially the exact scale and size of objects in the world. Recent improvements in natural feature detection, tracking and recognition have also led to natural features being used instead of the traditional marker to estimate pose and motion of a mobile device (see (Bay, Ess, Tuytelaars, & Van Gool, 2008; Kurz & Ben Himane, 2011; Wagner et al., 2008)).

The need for determining location of the user/viewer is usually a prerequisite to be able to correctly augment the viewed world with additional virtual information or content. There is a wide range of domains to which augmented reality is effectively used including entertainment, education/training, interaction with virtual objects (see (Chang, Koh, & Been-Liirn Duh, 2011a; Olsson & Salo, 2011; de Sa, Churchill, & Isbister, 2011). In all cases, the content needs to correctly be augmented onto the video captured by the camera and displayed to the user coherent with the perspective of the user. For this purpose, using a marker is typically a standard robust approach to determine the correct perspective of the user.

However, AR goes beyond simply augmenting the visual experience of the real world with virtual content. Many AR applications require interaction of the user with the virtual content (Chang et al., 2011a; Chang, Koh, & Been-Liirn Duh, 2011b; Gjosaeter, 2009; H. Kato, Billinghurst, Poupyrev, Imamoto, & Tachibana, n.d.; Olsson & Salo, 2011; Papagiannakis, Singh, & Magnenat-thalmann, 2008). In this context, the metaphors used for interaction, the enabling technologies and display techniques, all play a key role in overall user experience. The variation of interaction in the mobile AR context is large, and beyond the scope of this paper (see (Kolsch, Bane, Hollerer, & Turk, 2006; Papagiannakis et al., 2008) for an overview of interaction with AR systems and enabling technologies). We shall instead focus on AR with hand-held devices such as mobile phones and particularly those relevant to the application of modeling and manipulation of 3D objects using AR for virtual furnishing.

**Interactive AR Based Furnishing**

We present Happy Measure, a novel system that allows the user to photograph furniture or other objects using their mobile phone camera and directly measure their sizes from the image alone. We are interested in the overall size of objects rather than detailed measurements of individual parts of the object. We therefore define the size of the object in terms of its bounding box as shown in Figure 1(top right). While manually measuring furniture and objects would provide very accurate results, it does not provide the sense of space occupied by an object nor how it would look when placed there. This issue is further complicated if the object in question is
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