# Composite Images on Mobile Devices Augmenting Reality in an Outdoor Environment

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## ABSTRACT
Mobile devices like cell phones, handhelds, and other gadgets are useful tools in organizing and communicating. This is going to change. Recent developments in hardware have proven that such small devices are much more capable and have reached the levels of common laptops as of five years ago. With more computational power, more memory, and new methods of interaction such as touch screens, or accelerometers, mobile devices can be used in the design process.

However, the assumption that they can, or will, substitute desktop computers might be misleading. By no means will mobile devices substitute them directly. Instead, thinking of them as innovative tools that provide new approaches in the design process can establish new methods and, consequently, might circumvent the overall need of desktop computers at all.

## 1 COMPOSITE IMAGES
One approach that these small devices may make possible is the implementation of composite images. These systems are already at hand: Composing images from various sources is a long-standing technique in figurative painting and photography. Today with computers, composed images are more common than unaltered images. From metadata to overlaid writings, almost every image carries more information than its initial visual impression.

### 1.1 AUGMENTING REALITY
Combining multiple images into one image, or two or more video streams into one stream, has become a technique known as Augmented Reality. Images from real-world sources are combined or augmented with images from virtual sources. Regarding the approach of implementing composite images, to synchronize the viewing directions, two techniques have emerged: either the real-world camera is based on multiple tracking devices, or systems are located in environments covered with markers.

If a camera's position is determined completely with additional devices such as gyroscopes, accelerometers, and positioning devices, the output device integrates the virtual augmentation directly into the viewing field of the user. Thus, a typical application tracks both input and output devices simultaneously, as an HMD. If the system is based on markers totally covering every viewing angle, like in a TV studio, the camera is bound to that place.

Neither approach is suitable for mobile devices. The screen on a mobile device is designed as a viewfinder, not as a display for composite images, and definitely not as an HMD. If synchronizing is performed and composite images are displayed, then the small display would be a simple viewer, and that would be sufficient in the architectural design process. Therefore, only basic tracking is needed.

Covering a scene with markers is also not desired. Besides physical constraints regarding the size and number of markers, the real benefit of every outdoor system is unlimited maneuverability, and this is not afforded with the mandatory deployment of at least three markers or by using calibrated or fixed cameras.

## 1.2 THE EXISTING SYSTEM

The considerations addressed above led to the existing system. This system's main feature is the single marker, with some added tracking to permit synchronizing. Using markers always provides the best rendering results, because the process of synchronization is solely based on the image. If tracking is established, then a single marker is sufficient as a fiduciary feature, and processing the image is very effective because only one single feature is identified and interpreted. The additional tracking is based on simple location devices on both the camera and the single marker. The scale of the marker, which would be a simple balloon, depends directly on the scale of the virtual model.

**Figure 1 and 2 Image** Processing and Simple Prototype on the iPhone

## 1.3 MOBILITY

While a working prototype has been under constant development for five years, mobility remains an important challenge. A laptop computer, a camera, and a GPS are all that was needed to establish the viewing part of the system. Most of this is already available in current mobile phones. All that is missing are sufficient computational power and the ability to develop software on mobile devices, which tend to be closed environments. With the introduction of the Apple iPhone Software Developer Kit, this last hindrance is nearly removed. Our current system is presently being ported to the iPhone.

## 2 CELL-PHONES AND HANDHELDS

Mobile devices such as cell phones or handhelds are useful tools to establish communication everywhere. Only small but important information were considered suitable on mobile devices. This is going to change. Recent developments in hardware have proven that such small devices are much more capable and can be used almost like desktop computers. However mobile devices are limited in numerous ways. They lack a real keyboard, some important interfaces, and the size needed for proper manipulation. In particular, the special demands of battery-life deny the use of brute-force computing. Incoming calls on a cell phone can also have bad side effects for the system. In addition, the demands regarding licensing and security lead to special strategies for locking parts of a mobile device's functionality. This type of blocking has become more of an impediment to development than initially anticipated.

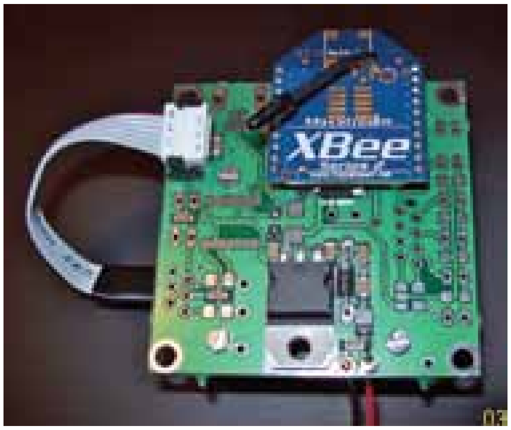
## 2.1 HARDWARE

A major problem is still the connection between the location device on the marker and the computer, needed to transmit the marker's position to the computer. Off-the-shelf tracking devices based on cell phone technology require additional servers, and their update interval is usually not suitable for real-time composite images based on possibly moving markers. Another option has emerged only recently, based on the "Zigbee"-standard. Now the 0.9 GHz band, previously used for the first generation of cell phones, is open and can be used. These chips, with a range of about ten miles, and GPS receivers are soldered on custom designed boards. However, there is no way to connect them to a mobile device. The receiving chip is still connected to a laptop.

## 2.2 INTERFACE DESIGN AND USABILITY

An essential part of the system is the modeler. This still-basic tool lets users create three-dimensional models on-site. Because an overlaid image is produced and both views—the real-world and virtual views—are synchronized, the virtual model appears as a realistic building in the real-world image. Every modification is immediately displayed as a spatial augmentation.

Overlaid objects are part of a composite image on a touch screen. Therefore, interacting with the system by creating and manipulating three-dimensional shapes is essential.



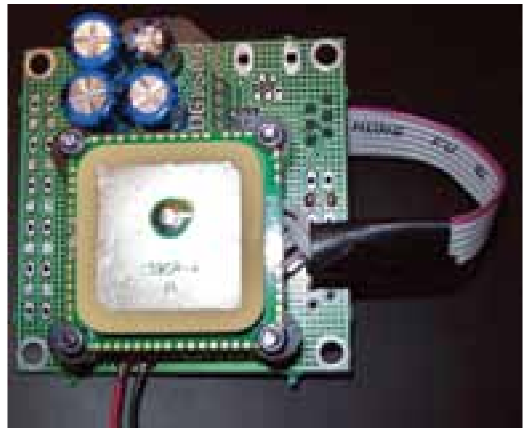



**Figure 3 and 4**
Board with Xbee-chip and backside with GPS-receiver

## CONCLUSION

Developing the system to augment reality through composite images (fig.1–4 and fig. 6) over some time has shown that the usability of it depends mainly on its deployability. While the system already shows acceptable results on laptop computers, mobile devices are much more desirable. In theory, they can handle all requests. In practice, the technology presented here is still under development. Namely, accessing the marker and its positioning device from a mobile device is a significant problem. Performance and usability are still issues on both platforms.

The vision remains: With mobile devices, new forms of design are imaginable. Augmenting real-world scenes with virtual, three-dimensional models permits immediate alternate designs. Given that one of the strengths of cell phones is communication, a rapid design process is thinkable.

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