Mobile AR4ALL

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Abstract

The AR-PDA project develops a framework that allows the use of mobile AR applications for the consumer market. Adapting existing technologies for PDAs (personal digital assistants), high speed wireless computing, computer graphics and computer vision, AR services will be provided at low costs. In this paper, we discuss the suitability of mobile devices for AR, address problems of wireless network transmissions and latencies. We present a first running prototype of a wireless PDA with AR features demonstrating a proof-of-concept for a mobile AR system that addresses the consumer market.

1. Introduction

The basic idea of the AR-PDA project [1] is to introduce a personal digital assistant for augmented reality based services. Using the intuitive metaphor of a magic pocket lens, end users will be able to easily interact with mobile AR applications in many different scenarios. The AR-PDA should support consumers during their daily activities like shopping, during sightseeing tours, playing games, or using household appliances and other technical devices.

2. The AR-PDA Approach

Many existing mobile devices fulfil the basic requirements for augmenting real world pictures with computer generated content, e.g., next generation mobile video phones, PDAs with mounted camera or sub-notebooks. Due to existing PDA's processing power, a high speed network connection is still necessary to distribute tasks like image recognition, 3D rendering, compositing, and video streaming to a server. The images of a camera mounted on the device are encoded and sent via a wireless network to a server. The server analyzes the image and detects objects and their position and orientation in space. The application logic decides what additional content is needed and how it is generated (Text, 2D, 3D, Sound). The generated content is then mixed with the image. The augmented images are encoded and sent back over the network to the AR-PDA which decodes and displays the images. User interactions are processed in a similar way. Fig 1 illustrates our current client/server approach.

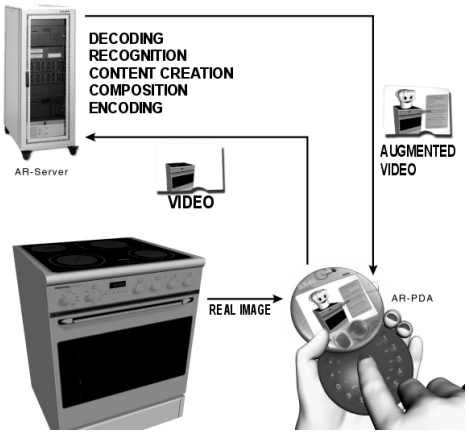

Figure 1. AR-PDA concept

To support end users in the consumer domain we currently use the *magic lense* metaphor similar to the approach of Fitzmaurice [2] who used a small TV screen. Rekimoto's NaviCam system [4] is also strongly related to our work. The idea of wireless network transmission for small mobile devices has also been published by Pyssysalo [3].

3. Mobile AR-Devices

Currently, most mobile AR systems use specialized laptops, wearable computers (e.g. Cybernaut, Espresso) or special AR hardware rather than PDAs. If AR services should be offered to a wide range of possible users, standard consumer electronic devices have to be applied. There is a wide range of mobile devices which can be used for a

mobile AR unit. At one end of the available spectrum, mobile video phone are (nearly) ready to enter the consumer market. All major telecommunication companies are currently developing video mobiles for 3rd generation of mobile networks. Due to the existing proprietary operating system, AR software can hardly be loaded onto such devices. Additionally, existing processors in mobiles like Hitachi's SH3 are currently not powerful enough for AR processing. Therefore, most of the computation has to be done on a server which is connected to the video mobile. We expect that future mobile phones will significantly increase their effectiveness (similar to today's standard PCs). The bandwidth of wireless network standards like UMTS will allow streaming interactive video and audio in real time.

At the other end of the spectrum small laptop computers are equipped with a camera module and some kind of network access, e.g. wireless LAN. Although the computation power on-board is capable of efficiently realizing AR tasks, the size of laptop computers prevent them from being used for daily tasks like shopping, sightseeing, etc.

Pocket PCs and PDAs allow a smooth transition between these two extremes, e.g. there are already mobile phones on the market which use PDA operating systems like PalmOS. HP's Journada 720, for example, is a small but complete WinPC and Compaq's IPAQ is currently the most powerful PDA capable of playing videos at high framerates. The Trium Mondo is one of the first WAP enabled GSM/GPRS phones running under Pocket PC's WinOS.

In our studies we found that current PDAs can be used as mobile AR devices if equipped with a camera module and some kind of network access. Current PDAs often use StrongARM processors which are powerful enough to do simple computer vision tasks. They are small enough for single handed use and can therefore be used as a *magic lense*.

The type of network in use is also an important issue. Circuit-switched networks like UMTS and packet-switched networks like TCP/IP have different latencies and transmission times. For real-time AR interaction this is a crucial point. Using a mobile video phone, all images have to be transmitted to the server where they are analyzed, augmented, and sent back to the device. This procedure usually generates high latencies, especially for packet switched transmission modes. If more sophisticated devices like PDAs are used, simple tasks like color segmentation can be done at the client. This decreases network load and minimizes latencies. But state-of-the-art PDAs are still not powerful enough to do higher tasks like efficient 3D rendering.

4. Prototype

The goal of our project is to use commercial video mobile phones as mobile AR device although such devices are not yet available. We built a first prototype using a Compaq iPAQ 3630 PocketPC with WirelessLAN and a Philips TriMedia 1100 multimedia microcontroler for video/audio processing. To be as close as possible to the H.324M specifications which will be used for future video mobiles we use H.263 as video format for de/encoding which is part of the H.324M specifications. Images are captured using a small camera mounted at the IPAQ.

Figure 2. Demo Scenario of the AR-PDA

We built two simple demo applications for the iPAQ. The first one is a AR soccer game. The user kicks the virtual ball with his real foot and tries to score a penalty goal beating a virtual goal keeper. The second demo features a 3D character explaining how to insert a (virtual) memory card into a real digital camera. All AR computation is currently done on a PC server running Linux. With our prototype we did some performance tests using a picture size of 320x240 pixel. The mean time for encoding, sending over the network, analysing, augmenting, encoding, sending back and finally decoding is about 300ms (latency). The demos run with about 10-12 frames per second due to some parallel processing in the steps above.

References

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