Graphical Content on Mobile Devices

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INTRODUCTION

The enthusiasm for mobile computing is still unbroken as a year on year increase of 51% in the overall global shipments of mobile devices in the fourth quarter of 2004 has shown (Canalys.com, 2005). With 300 million new subscribers in 2004 alone, 27% of the world's population now has access to mobile communications (Svanberg, 2005). A mobile device is a natural multi-functional device and the opportunity to handle multimedia data is only the first step on a long way. Although the development of mobile devices has already made great progress, handling graphical data is still expensive due to the limited resources in mobile environments. Especially if large graphics must be processed limits are quickly reached. However, it is necessary to provide effective and appealing graphical representations for successful m-commerce.

The aim of this article is to derive major limitations of current mobile hardware and to show how large graphical content can be appropriately processed on such devices. Since visual content can be described either by vector (SVG, Flash) or raster data (Bmp, Gif), both approaches are explained and particular properties are shown. Based on experimental results, this enables us to give guidelines for the appropriate handling of large graphical contents in m-commerce applications.

This contribution is structured as follows: in the section titled "Background", properties of current mobile devices are reviewed and the displaying pipeline together with basic principles of vector and raster images is explained. These statements form the basis for our tests and comparisons in the "Main Discussions" section and statements for future work in the "Future Trends" section. Since there are huge differences in the performance in the handling of vector and raster images, we close our contribution by giving implementation guidelines for applications presenting large graphical content on mobile devices ("Conclusion"). "References" and "Key Terms" serve to provide sources for cited literature and definitions for related terms.

BACKGROUND

Recent Work

Effectively representing information by graphical means is a key issue in m-commerce applications. Many publications describe the processing of graphical content in mobile environments, but they are rather limited to WWW-browsers (Joshi et al., 1996), interaction issues (Rekimoto, 1996) or other specific problems (Rist, 2001; Want et al., 2002; Karstens, Rosenbaum, & Schumann, 2003). Nevertheless, these publications neither describe the actual efforts needed to process the used graphical data, nor do they consider the nature of the content description actually used. Due to limitations of mobile devices, this can be of crucial interest since each kind of data is processed differently, which might even render an accepted approach impossible if provided resources are exceeded. This has been shown in (Rosenbaum & Tominski, 2003) by a comprehensive investigation of the processing and display pipeline of mobile hardware.

Related Limitations of Mobile Devices

Due to fast progression in this research field, properties of mobile devices change quickly. Thus, current limitations regarding the handling of large images are not the same as a few years ago (Rosenbaum & Tominski, 2003). We found, that some constrains still exist (e.g., screen size/resolution, processing power), whereas some have strongly decreased (storage space) or have been overcome (lack of color). To give the reader an impression of current hardware, we compiled a list of important properties of current mobile devices (Table 1). Since classic tablet-PCs or Laptops are more aligned to stationary systems than to light-weight mobile assistants, they have not been considered.

Table 1. Specifications of different mobile devices (03/2005)

Devices	Display	Resolution	Colours	Processing power	RAM
Mobile:					
Siemens SXG75	2.2”	240 × 320	18bit	-	128MB
Hagenuk S200	2.2”	160x220	16bit	Texas Instruments OMAP 310	32MB
Samsung i600	- -	176x220 128 x 32	16bit -	Intel® PXA250 200MHz	32MB
Palm Treo 650	2.5”	320x320	16bit	Intel® PXA270 312MHz	32MB
Asus **MyPal** P505	2.8”	240x320	16bit	Intel® PXA272 520MHz	64MB
Qtek 9090	3.5”	240x320	16bit	Intel® PXA263 400MHz	128MB
Palmsize:					
Palm Zire 72	2.5”	320x320	16bit	Intel® PXA270 312MHz	32MB
BlackBerry 7750	3.0”	240x240	16bit	-	16MB
Palm Tungsten-T5 Premium	3.7”	320x480	16bit	Intel® PXA272 416MHz	256MB
Sony Clié PEG-UX50	4.0”	320x480	16bit	Sony CXD2230GA 123MHz	64MB
Handheld:					
Gizmondo Force	2.8”	240x320	-	Samsung ARM9 S3C2440 400MHz + GPU Nvidia Goforce 3D 4500	64MB
Fujitsu Siemens LOOX 720	3.6”	480x640	16bit	Intel® PXA272 520MHz	128MB
Sharp Zaurus SL-6000	4.0”	480x640	16bit	Intel® PXA255 400MHz	128MB
Toshiba Pocket PC e830	4.0”	480x640	16bit	Intel® PXA272 520MHz	128MB
Dell Axim X50v	3.7”	480x640	16bit	Intel® PXA270 624MHz + GPU Intel® 2700G - 16MB	196MB
HP iPAQ HX4700	4.0”	480x640	16bit	Intel® PXA270 624MHz	128MB
Sony VAIO U71	5”	800x600	24bit	Intel® Pentium® M733 1100MHz + GPU Intel® 855GME – 64MB	512MB
Stationary PC:					
generic	21”	2048x1536	32bit	Intel® P4-570J 3800MHz + GPU Nvidia GeForce 6800 Ultra	1 GB

Screen Dimension

The relatively small screen dimension is one of the major drawbacks of mobile devices if large graphical content is to be presented. The display size of current devices varies dependent on the respective device class and spreads from 2 to 5 inches screen diagonal, which is by far less than what is offered by common stationary devices. Thus, the available space for presenting images is very limited and most parts of the content might be hidden. Interestingly, some mobiles offer a second, smaller display to show additional data.

Screen Resolution

The pixel density of mobile displays is rather high. Some devices offer a resolution of 800×600 by a screen dimension of only 5 inches. This leads to a very detailed presentation of the content. Nevertheless, this property is limited by the human visual system, which can resolve visual content only up to a certain extent (Hubel, 1988; Wandell, 1995). Thus, the provided space to display data is and will be by far lower compared to stationary gadgets.

Processing Power

The appropriate handling of graphical content is heavily affected by the available processing power. Due to the dimensions of mobile devices, it is not possible to include hardware with performance similar to stationary devices. This is mainly due to the limited energy supply. Although the speed of current systems has increased a lot, the performance regarding data processing is innately much slower. An interesting trend is the use of additional GPUs to improve the processing of graphical data. Currently, they are only provided by two devices specialized on gaming (Gizmondo) or highly detailed output (Sony VAIO), but are expected to be supported by other devices too. The advent of such additional peripherals will strongly enhance the handling of visual content in the near future (Rasmusson, Dahlgren, Gustafsson, & Nilsson, 2004).

Other Limitations

As predicted in (Rosenbaum & Tominski, 2003), nowadays mobile devices offer by far more storage space than two years ago (Table 1). Thus, limitations in image handling are mostly overcome and might only occur if many images must be handled or stored at same time. Minor limitations, as user interaction and data transmission, do not influence content presentation and are considered to be out of scope for this article.

Presenting Graphical Content on Mobile Devices

Working with mobile hardware causes a variety of problems due to limited capabilities of such devices. In this section we want to review basic steps of the display pipeline for graphical data together with important properties and requirements which should be fulfilled to allow