



Windows Mobile Customer Solution Case Study



Groundbreaking Augmented Reality Applications Target Windows Mobile Devices

Overview

Country or Region: Austria
Industry: Education—Higher education institutions

Customer Profile

Graz University of Technology specializes in teaching and research in the fields of engineering and the technical-natural sciences. The University is based in Graz, Austria.

Business Situation

For a doctoral research project, a Ph.D. student set out to create a practical augmented reality (AR) framework that would target multiple users and run autonomously on handheld devices.

Solution

The student has created many successful AR applications for mobile devices by using the Microsoft® Visual Studio® 2005 development system and targeting devices running Windows Mobile® software.

Benefits

- Familiar development tools
- Powerful, convenient development framework
- Timesaving APIs

“With Windows Mobile and Visual Studio 2005, it is easier to develop powerful AR applications than with any other mobile development platforms we’ve evaluated so far.”

Daniel Wagner, Research Assistant, Graz University of Technology

Graz University of Technology is known internationally as an important hub of technical and natural-scientific research. A student on the Augmented Reality research team of the Institute for Computer Graphics and Vision chose “multiple-user augmented reality on handheld devices” for his research project. Augmented reality, which combines real-world and computer-generated data to help users navigate an experience or task, had never before been aimed at mass-market handheld devices. After evaluating all options, the student chose to target Windows Mobile®, powered devices and to use Microsoft® Visual Studio® to develop his applications. By using Visual Studio, the student was able to use his existing Windows® development skills to create mobile AR applications, and found that the development system provided power, convenience, and time-saving application programming interfaces (APIs).



“Our previous experience with Windows development made developing for Windows Mobile much easier than working on a completely new platform.”

Daniel Wagner, Research Assistant,
Graz University of Technology

Situation

Graz University of Technology pursues top teaching and research in the fields of engineering and the technical-natural sciences. The university is an important hub of international technical and natural-scientific research and education, and participates in many large European Union research projects. Located in the city of Graz in southern Austria, the university has 11 key research areas and employs nearly 1,900 people.

In 2002, Ph.D. student Daniel Wagner, a member of the Augmented Reality research team of the Institute for Computer Graphics and Vision at Graz, needed to choose a topic for his research project. “My professor gave me a handful of choices that were connected to augmented reality,” says Wagner, Research Assistant, Graz University of Technology.

The research project that Wagner chose was to create a stand-alone, mobile augmented reality (AR) system for popular consumer handheld computing devices—with the goal of potentially reaching mass numbers of people. “Augmented reality is a natural complement to mobile computing,” says Wagner. The pervasiveness of handheld devices today presents a vast potential audience for the use of AR applications in realistic scenarios.

Simply put, AR combines real-world and computer-generated data to augment a user’s experience of a task, environment, game, or situation. Computer graphics and audio are superimposed onto a live video image of a three-dimensional (3D) reality, and the user can interact with the information that is presented. Some uses of AR include location-based information systems, navigation aids, and entertainment (including games such as ARQuake and AR versions of Chess and Maze). Uses for AR are also being

explored in medical, surgical, and educational scenarios.

While wearable AR systems technically are “mobile,” they are very heavy and are socially impractical, because they consist of a head-mounted display that is attached to computer hardware that the user must carry in a large, heavy backpack. In contrast, a handheld device such as a personal digital assistant (PDA) or a smartphone “has the perfect form factor for a self-contained and lightweight interactive computing platform,” says Wagner.

The project goal in the beginning was simply “to find out what was possible at all,” says Wagner. “Previous research on handheld AR used the devices only as a thin client, or display. The device camera captured the video image, sent it to a nearby server, and the server processed the image, overlaying it with 3D graphics and sending it back to the device. In this scenario, the device itself is merely a display, reliant on a nearby server for interactive processing.” In contrast, Wagner’s goal was “to do everything on the device.”

“Because nobody had ever tried something like this before, and we had no experience in programming handheld devices,” Wagner says, “it was hard to guess how far we could go.”

Solution

When Wagner started the project four or five years ago, he looked at developing for Palm and Symbian devices, as well as for devices powered by Windows Mobile® software. “Since then, I use only Windows Mobile,” says Wagner.

Wagner uses the Microsoft® Visual Studio® 2005 Professional Edition development system to develop AR applications on top of the research team’s Studierstube

“The DirectShow API was an extremely important step forward for us ... Now, we only need to support one camera API: DirectShow.”

Daniel Wagner, Research Assistant,
Graz University of Technology

development framework. Studierstube is an operating framework that the research team created nearly 10 years ago to create and test its AR applications. (In 2006, the group created Studierstube ES [embedded subset] developed exclusively for handheld AR.)

Wagner has created a variety of handheld AR applications since the project began, including Kanji Learning, an application that uses collaborative AR to teach the meaning of Japanese kanji symbols. The educational game was designed for two players, who use PDAs on which the software is installed. The players sit opposite one other, with 10 specially designed cards turned face down between them. A different kanji symbol is on each card. The application prompts the first player to search for a specific term—for example, “tree.” As the player selects a card and turns it over, the camera on the PDA acts as a “magic lens” to read the card. The software determines whether the card is a match to the search term. If it is, the player can continue; if not, it is the next player’s turn. The AR application retains system state, including the kanji symbols that haven’t yet been found, the current card that is selected, and the score of both players.

“The novelty of our approach was that we did not use regular workstations or laptops to host the AR application,” says Wagner. “Instead, we used fully autonomous PDAs, running the application together with an optical marker-based tracking module to read the symbols. This makes the application not only available for a broad audience but also makes it optimally mobile.”

In 2003, Wagner created Signpost 2003, an application that guides a user through an unfamiliar building to the user’s destination. The user points the camera lens toward a fiducial marker that is attached to the building wall for location reference. The user can then select “Show Map” to see a

wireframe map of the building, with a marker indicating the user’s current location. The user can then select a target location, or room, and the application will produce floating colored markers on the PDA screen to guide the user to the chosen destination. As the user walks, the application continuously optically tracks and interprets camera input, including wall-mounted fiducial markers, and provides continuous real-time feedback in the form of arrows and optional map views.



Figure 1: Signpost 2003 showing the way



Figure 2: Signpost 2003 overview map

“One primary goal of our development was to rely solely on standardized, widely available hardware to extend the range of practical applications,” says Wagner. “For our work, we choose a Pocket PC 2002 device (the HP iPAQ 5450) that had a 400 megahertz (MHz) Intel XScale processor, 240 x 320 16-bit display, 64 MB of RAM, and an IEEE 802.11b wireless network interface. We extended it with an inexpensive camera that had 320 x 240 color resolution, attached via an HP

CompactFlash jacket." The camera performs the roles of both optical tracking device and video see-through display source.

In 2007, Wagner released Signpost 2007, which was the first application to use the Studierstube ES platform that the team created in 2006 specifically for handheld AR applications. Wagner says, "Signpost 2007 is the first AR application that was developed to target a large public audience. More than the usual research demonstration application, it was designed from scratch with commercial product quality in mind."

Signpost 2007 is a "location-aware conference guide." The application lets users browse conference or event schedules, view maps of session locations, and locate a particular destination. The application also includes an "AR treasure hunt" game in which users can search for virtual 3D objects. "Conference or event organizers can announce prizes for users who find all of the hidden virtual items," says Wagner.

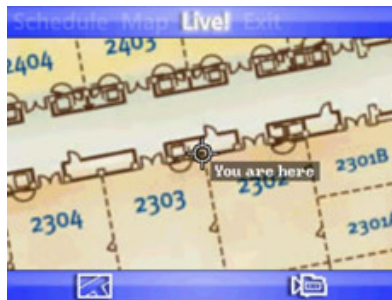


Figure 3: Signpost 2007 live position and orientation



Figure 4: Signpost 2007 current target and location

Wagner specifically ported and tested this application to a wide range of devices, including devices that run the Windows Mobile operating system: HTC Tornado Noble, Palm Treo 700W, Motorola Q, HTC Excalibur, HTC Wizard, HTC Star Trek, HTC Artemis, and HTC Vox.

Signpost 2007 was introduced to a public audience in May 2007 at the Microsoft Mobile & Embedded Developers Conference 2007 in Las Vegas. There are plans to deploy Signpost 2007 at future Microsoft conferences.

Requirements

Devices that are running the AR applications should have "a fast CPU, a good built-in camera, and maybe a 3D graphics accelerator," says Wagner. "The camera should have a resolution of at least 320 x 240, and a minimum frame rate of 15 Hertz (Hz), to allow for interactive applications and relatively accurate tracking. The camera should work well in various lighting conditions, ranging from poorly-lit rooms to outdoor areas with direct sunlight." Currently, "The AR applications can run on any Windows Mobile system," says Wagner.

Benefits

By using Visual Studio 2005, Wagner was able to use his existing knowledge of Windows® development for handheld AR

application development. Visual Studio offers a powerful development framework with convenient and timesaving application programming interfaces (APIs).

Familiar Development Tools

According to Wagner, "Our previous experience with Windows development made developing for Windows Mobile much easier than working on a completely new platform." Wagner was able to transfer all of his experience with the Windows languages, tools, runtimes, APIs, and data sources to handheld AR development. "Today, I think we made a very good choice by choosing Windows Mobile," he says.

Powerful, Convenient Development Framework

"When we began AR development, Windows Mobile devices were the most powerful devices of their kind, and they still are," says Wagner. "We chose to develop Signpost 2003 on the iPAQ Pocket PC primarily because of the device's unrivaled ratio of performance to size and weight, and its integrated input and output features."

Although Wagner considered developing for other software, he says, "With Windows Mobile and Visual Studio 2005, it is easier to develop powerful AR applications than with any other mobile development platforms we've evaluated so far, including Symbian with CodeWarrior or Carbide C++."

"The framework gives us the ease of running an application on Windows XP ~~and~~ Windows Mobile—the 'and' is important. It means that we can do most of our development on a PC with Windows XP, which is easy and convenient, and only do final testing on the handhelds, which is more time-consuming than on a PC," says Wagner.

Timesaving APIs

Windows Mobile 5.0 introduced the DirectShow API, which provides Wagner and his team with a generic solution to access device camera and video sources. "The DirectShow API was an extremely important step forward for us," he says. "We no longer depend on different device creators to provide software development kits for their built-in cameras—which they rarely did. Now, we only need to support one camera API: DirectShow. For us, DirectShow was a very important feature that was added with Windows Mobile 5.0."

By writing AR applications that run across a wide range of Windows Mobile devices—including more than 100 phones carried by 93 operators in 55 countries—Wagner might reach the massive audience that he was originally aiming for.

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Windows Mobile

Windows Mobile brings the power of the Windows operating system to mobile devices, helping businesses and their mobile employees stay connected while on the go. Windows Mobile runs mobile versions of Microsoft programs, including Microsoft Office Outlook® Mobile, Internet Explorer Mobile, Pocket MSN®, Windows Media® Player Mobile, and Microsoft Office Word Mobile, PowerPoint® Mobile, and Excel® Mobile. With Windows Mobile, information workers get powerful software combined with the familiarity of Windows. Combined with available service plans and connectivity options, Windows Mobile-based devices, available from 42 device makers and 68 mobile operators in 48 countries, can be used to make calls, send e-mail and instant messages, surf the Web, and access critical business information even when users are away from the office.

More information about Windows Mobile can be found at:

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