Pen-Based Mobile Computing

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INTRODUCTION

The original idea of a portable computer is credited to Alan Kay of the Xerox Palo Alto Research Center who suggested the idea in the 1970s (Kay, 1972a, 1972b; Kay & Goldberg, 1977). He envisioned a notebook-sized portable computer named the "Dynabook" that could be used for all of the user's information needs and using wireless network capabilities for connectivity.

BACKGROUND

Origins: Laptop Computers

The first actual portable "laptop" computers appeared in 1979: the Grid Compass Computer was designed in 1979 by William Moggridge for Grid Systems Corporation (Stanford University, 2003). The Grid Compass was one-fifth the weight of any model equivalent in performance and was used by NASA on the space shuttle program in the early 1980s. Portable computers continued to develop in the 1980s onwards, and most weighed around about 5 kg without any peripherals.

In 1984, Apple Computer introduced its Apple IIc model (Abbate, 1999), a true notebook-sized computer weighing about 5 kg without a monitor. The Apple IIc had an optional LCD panel monitor which made it genuinely portable and was therefore highly successful.

In 1986, IBM introduced its IBM Convertible PC with 256KB of memory; it was also a commercial success. By many, this is considered the first true laptop (mainly due to its clamshell design) that was shortly copied by other manufacturers such as Toshiba who were also successful with IBM laptop clones (Allen, 2001; Cringely, 1996). These devices retained the A4 size footprint, full QWERTY keyboards, and weighed between 3 and 4 kg (IBM, 2006). Following these innovations "tablet" PCs with a flat A4 footprint and a pen-based interface began to emerge in the 1990s.

There were several devices in the 1970s that explored the tablet, but in 1989 the Grid Systems GRiDPad was released, which was the world's first IBM PC-compatible tablet PC that featured handwriting recognition as well as a pen-based point-and-select system. In 1992, Microsoft released Microsoft Windows for Pen Computing, which had an application programming interface (API) that developers could use to create pen-enabled applications. Focusing specifically on devices that use the pen as the primary input device, this interface has been most successfully adopted in the new breed of small, highly portable personal digital assistants (PDAs).

Personal Digital Assistants

In 1984 David Potter and his partners at PSION launched the "PSION Organiser" which retailed for just under £100 (Troni & Lowber, 2001). It was a battery-powered, 14 x 9cm, block-shaped unit with an alphabetic keyboard and small LCD screen, with 2K of RAM, 4KB of applications in ROM, and a free 8KB data card (which had to be reformatted using ultraviolet light for reuse). Compared to the much larger notebook computers of the time, it was a revolutionary device, but because of its more limited screen size and memory, it fulfilled a different niche in the market and began to be used for personal information management and stock inventory purposes (with a plug-in barcode reader).

In the late 1980s and throughout the 1990s, PSION continued to develop commercially successful small computing devices incorporating a larger LCD screen, and a new fully multi-tasking graphical user interface (before even Microsoft had got Windows up and running). These small devices were truly handheld. The PSION 3c (launched in 1991) dimensions were 165 x 85 x 22 mm, with a 480 x 160 pixel LCD screen, and the device weighed less than 400 g. A small keyboard and innovative touch-sensitive pad provided control of the cursor, and graphical icons could be selected to start applications/functions and select items from menus. The small keyboard proved difficult to use however, and the following 5c model in 1997 used an innovative foldout miniature QWERTY keyboard. These genuinely "handheld" devices with their interface innovations and ability to synchronize data with a host personal computer made the PSION models particularly successful and firmly established the personal digital assistant as a portable computing tool for professionals.

Pen-Based Interfaces for the PDA

The limitations of keyboard-based data entry for handheld devices had been recognized, and following PSION's lead, Apple Computers introduced the Newton Message Pad in 1993. This device was the first to incorporate a touch-sensitive

screen with a pen-based graphical interface and handwriting-recognition software. Although moderately successful the device's handwriting recognition proved slow and unreliable, and in 1998 Apple discontinued its PDA development. However, the PDA market was now becoming firmly based upon devices using pen-based handwriting recognition for text entry, and in mid-2001, PSION, with dwindling sales and difficulties with business partnerships, ceased trading. US Robotics launched the "Palm Pilot" in 1996 using its simple "Graffiti" handwriting recognition system, and Compaq released the "iPAQ" in 1997 incorporating the new Microsoft "Windows CE/Pocket PC" operating system with the first PDA color screen.

Microsoft's relatively late entry into this market reflected the considerable research and development it undertook into developing a user-friendly pocket PC handwriting recognition interface. This remains a highly competitive field, and from November 2002 PalmSource (the new company owning the Palm Operating System) replaced the Graffiti system with Computer Intelligence Corporation's JOT as the standard and only handwriting software on all new Palm-powered devices. Computer Intelligence Corporation (CIC) was founded in conjunction with the Stanford Research Institute (SRI) based on research conducted by SRI on proprietary pattern recognition technologies (CIC, 1999). The original Graffiti system relied on the user learning a series of special characters, which while simple was irksome to many users. The CIC JOT and Microsoft Pocket PC systems have been developed to avoid the use of special symbols or characters and allow the user to input more naturally by using standard upper and lowercase printed letters. Both systems also recognize most of the original Palm Graffiti-based special characters. In 2006 Palm introduced the Windows Mobile (Pocket PC) operating system on its own high-end devices.

The Thumb Board Text Interface

The arrival of the short messaging service (SMS), otherwise known as text messaging for cellular phones, in the late 1990s led several PDA manufacturers to adopt an alternative Thumb Board interface for their PDAs. SMS allows an individual to send short text and numeric messages (up to 160 characters) to and from digital cell phones and public SMS messaging gateways on the Internet. With the widespread adoption of SMS by the younger generation, thumb-based text entry (using only one thumb to input data on cell phone keypads) became popular (Karuturi, 2003). Abbreviations such as "C U L8er" for "See you later" and "emoticons" or "smileys" to reduce the terseness of the medium and give shorthand emotional indicators developed. The rapid commercial success of this input interface inspired the implementation of Thumb Board "keyboards" on some PDAs (such as the Palm Treo 600) for text interface. Clip-on Thumb Board input accessories have also been developed for a range of PDAs.

Tablet Format PCs

The tablet PC provides a small (usually 10 x 12" screen size) rectangular format device equipped with a sensitive screen designed to interact with a device-specific pen. The pen is used directly to write or tap on the screen. It can be used in place of a keyboard or mouse for data entry; to select, drag, and open files; to draw on the screen; and to handwrite notes and communications. Tablet PCs also incorporate handwriting recognition and conversion to text software. Unlike a touch-sensitive screen, the Tablet PC screen only receives information from the device-specific pen. It will not take information from pressure applied to the screen, so users can rest their hands on the screen and write in a more natural way. Most Tablet PCs also come with optional attachable keyboards and docking stations so they can be used in the same way as a desktop computer.

A pen-based interface for the PC was developed in the early 1990s and was originally envisaged as a challenge to the mouse. Microsoft launched "Pen Extensions for Windows 3.1" in 1991 calling it "Windows for Pen Computing." The system was designed to use plug-in slate and pen systems. However, pen-based systems would take another 10 years to become established. Shortly after its launch a number of companies introduced hardware to support it. Among them were Samsung, Fujitsu, Compaq, Toshiba, and IBM. The original IBM ThinkPad was designed as a pen-based computer. However, these pen-based systems were not well received, as many users found the Windows interface difficult to use with the stylus, and by 1995 sales of pen-based systems failed to support their further mainstream development. Bill Gates remained a strong supporter of the interface, and Microsoft decided to reintroduce pen computers as the "Tablet PC" in 2002. This time the Tablet PC specification was more successful as the use of touch-screen technologies for the pen (not well developed in the 1990s), handwriting recognition, and better integrated smaller devices made the portable tablet more acceptable for consumers.

The tablet PC has proved popular for specialist uses such as in the classroom, for creative artistic use, or more recently as the platform of choice for electronic flight planning/mapping software in aviation. A growing number of manufacturers are now producing Tablet PC hardware. However, the format still retains a far smaller proportion of the mobile PC market compared to laptops and PDAs.

MULTIMEDIA AND WIRELESS INTEGRATION

Current developments in pen-based computer interfaces are exploring the use of multimedia, voice recognition, and wireless connectivity. The expansion of memory capabili-