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(54) Title: MICRO PERSONAL DIGITAL ASSISTANT

(57) Abstract

A personal digital assistant module (10) with a local CPU (11), memory (13), and I/O interface (16) has a host interface (29) comprising a bus (26) connected to the local CPU (11) and a connector at a surface of the personal digital assistant (10) for interfacing to a bus connector of a host general-purpose computer (66), providing direct bus communication between the personal digital assistant (10) and the host general-purpose computer (66). In an embodiment, the personal digital assistant (10) also has a means for storing a security code. The personal digital assistant (10) according to the invention forms a host/satellite combination with a host computer (66) having a docking bay, wherein upon docking, a docking protocol controls access by the host (66) to memory (13) of the personal digital assistant (10) based one or more passwords provided by a user to the host (66). In another embodiment the personal digital assistant (10) also has an expansion port (20) connected to the local CPU (11), and expansion peripheral devices may be connected and operated through the expansion port (20). In yet another embodiment, an interface is provided via an interactive, menu-driven display (1016) and an on-board speaker (1013) to allow a user to select parties to be called, and to dial the parties, including credit card charge data, via DTMF tones generated by the on-board speaker (1013).
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Micro Personal Digital Assistant

Field of the Invention

This invention is in the area of portable computers and pertains more specifically to small portable computing devices known in the art as personal digital assistants.

Cross Reference to Related Documents

The present disclosure is a Continuation-in Part of copending applications S/N 08/144,231, titled "Micro Personal Digital Assistant", and S/N 08/058,922, titled "Computer-to-Telephone Interface".

Background of the Invention

Personal Digital Assistant (PDA) units, as of the date of this disclosure, enjoy a position of hope in the computer marketplace. Some believe this approach, a small, relatively inexpensive, and eminently portable computer unit, having software specifically written for tasks a user might expect to perform while travelling, will provide eminently useful and therefore salable computer products. Apple Computer, Hewlett Packard, and several other well-known computer manufacturers have made a considerable investment at no small risk in such systems.

Given the new systems now introduced, and those coming, for what is now known about them, there are still a number of drawbacks and problems. For example:

1. The PDA systems introduced are relatively costly, with starting prices ranging from several hundred dollars to two thousand dollars and more. At such prices, rivalling current pricing for desktop systems, the buying public may react negatively. It is true that prices will fall with increased manufacturing volume and competition, but
the high end start may well be rejected by potential users.

2. The systems being offered are still relatively bulky, considering the limited range of tasks that may be accomplished. Most are certainly too big to be conveniently carried in a breast pocket. The Newton, manufactured by Apple Corporation, weighs about a pound and is approximately the size of a VHS video cassette.

3. A big drawback of the PDA systems being offered is the way they transfer data between a user’s desktop unit, or other host, and the PDA. Known communication is by modem, by infrared communication, and by serial connection. These all require manipulation by a user, modulation on one or both ends of the communication path, and the like, which can be time-consuming, error-prone, and hardware extensive (expensive). Presently the Newton offers a modem and/or LED communication as an option, adding to the overall cost.

4. In known PDAs, software is typically recorded in ROM, so updating applications can be difficult, and sometimes impossible. This will be a problem because PDA users will not want the PDA to have the same capabilities at all times. Typical users will be people who travel and work while they travel. These users require different functions for a trip to Taiwan than for a trip to France, for example. What is needed is a quick and convenient means to update and substitute software.

5. Another difficulty is in the fact that the data files a user manipulates while travelling are typically data files also resident in a home unit, herein called a host unit, such as the user’s office desktop machine or notebook or other portable computer. It is very troublesome to have two or more sets of critical data, with differences that one must remember to correct at an appropriate time. This can cause unending grief if files are not correctly updated. At best, current PDAs must use a relatively slow compressed bus to download and upgrade files. Typically this is done through a serial port, using a
linking application like Laplink™.

What is needed is a small and inexpensive PDA that has a range of features that eliminate the above-described risks and problems. This new unit needs to be smaller than those presently being introduced, such as about credit-card size, or perhaps modeled on the PCMCIA type II or type III standard form factors. It should be inexpensive enough to produce that at least a minimum version could be sold in the roughly $100-$200 range, so it will be a unit seen to be a relatively inexpensive necessity. A PDA unit of this sort is the subject of the present invention, and is termed by the inventors a micro-PDA, or μPDA.

A very important feature of the μPDA in an aspect of the present invention is a direct parallel bus interface with a connector allowing the unit to be docked by plugging it into a docking bay in a host unit. Moreover, when the μPDA is docked in the host, there needs to be a means to effectively disable the CPU in the μPDA and to provide direct access to both the μPDA software and data storage by the host CPU. This direct access would provide immediate ability to communicate in the fastest available fashion between the μPDA and the host, and would also facilitate additional important features to be described below.

The μPDA also needs to have an optional compressed bus interface, including a connector separate from the host interface, so add-on devices may be utilized, such as a FAX modem, cellular communication, printer, and so on.

An additional feature that could be optionally provided in another aspect of the invention is an interface at the host to allow a user to select pre-arranged software mixes for loading to the μPDA. This feature comprises a set of control routines operating in conjunction with the host’s display and input means, to allow the user to quickly select applications and perhaps data as well to be loaded to the μPDA satellite, to configure the smaller, more portable unit for specific itineraries and purposes.
Another desirable feature is an ability to automatically update data files. In this aspect of the invention, with the μPDA docked, data on the host, if carrying a later date and/or time stamp than the data on the μPDA, would be automatically updated on the μPDA and vice-versa. When one returns from an excursion using the μPDA and docks the satellite at the host, the host gains access, determines the location of the latest files, and accomplishes the update. This feature needs to have some built-in user prompting to be most effective. It makes the μPDA a true satellite system.

Summary of the Invention

In a preferred embodiment of the invention a personal digital assistant module is provided comprising an enclosure for enclosing and supporting internal elements, a microcontroller within the enclosure for performing digital operations to manage functions of the personal digital assistant module, and a memory means connected to the microcontroller by a memory bus structure for storing data and executable routines. There is a power supply means within the enclosure for supplying power to functional elements of the personal digital assistant module, a display means operable by the microcontroller and implemented on a surface of the enclosure, and input means connected to the microcontroller for providing commands and data to the personal digital assistant module. A host interface means comprising a host interface bus structure, which may be configured as a PCMCIA bus interface, is connected to the microcontroller and to a first portion of a host interface connector at a surface of the enclosure, and the host interface means is configured to directly connect the microcontroller to a compatible bus structure of a host computer.

In one embodiment the personal digital assistant module has an expansion bus interface comprising an expansion bus structure connected to the microcontroller and to a first portion of an expansion
bus connector for connecting the microcontroller to a peripheral device. A wide variety of peripheral devices are provided for use with the personal digital assistant of the invention.

In another aspect, the personal digital assistant module also has a nonvolatile storage device, such as an EEPROM connected to the microcontroller and containing one or more codes unique to the personal digital assistant, for uniquely identifying the personal digital assistant to digital devices connected on the host interface.

In a preferred embodiment, the display and input means for the personal digital assistant are configured as an overlaid touch screen and LCD display on a surface of the outer case of the personal digital assistant. A pointer device implemented as a thumbwheel in one embodiment and as a pressure sensitive pad in another is provided as part of the input capability.

The personal digital assistant module forms a unique combination with a general-purpose computer host having the personal digital assistant as a satellite unit. The host in this instance has a docking bay especially configured to dock the personal digital assistant, making a direct bus connection between the local CPU of the personal digital assistant and the CPU of the host. The host may be a desktop unit, a notebook computer, or a smaller portable like a palmtop computer. This combination provides power and convenience not before available.

Many other digital devices are also provided according to various aspects of the invention, such as modems, scanners, data acquisition peripherals, cellular phones, and a software vending machine, and all of these devices may be appended to the personal digital assistant by the expansion bus interface or, in many cases, by the host interface.

The personal digital assistant provided according to embodiments of the present invention is a unit more compact than conventional PDAs. It represents a new dimension in computer
application and applicability, in a form promising to be eminently usable by and useful to almost everyone; and at a price easily affordable. It solves the communication problem intrinsic to personal digital assistants relative to larger and more powerful computers, with a unit that fits into a user's breast pocket, and at a very low price.

Brief Description of the Drawings

Fig. 1A is an isometric view of a µPDA according to an embodiment of the present invention.

Fig. 1B is a plan view of the µPDA of Fig. 1A.

Fig. 2 is a cross-sectional view of the µPDA of Figs. 1A and 1B.

Fig. 3 is a block diagram of the µPDA of Fig. 1A and some peripheral elements.

Fig. 4 is a more detailed plan view of the µPDA of Fig. 1A showing in particular an LCD display and touch screen user interface in an aspect of the present invention.

Fig. 5 is an isometric view of a µPDA and a host notebook computer in an aspect of the present invention, with the µPDA about to be docked in a docking bay of the notebook computer.

Fig. 6 is a block diagram of a µPDA docked in a docking bay of a host computer according to an embodiment of the present invention.

Fig. 7 is a logic flow diagram of the steps in docking a µPDA in a host computer according to an embodiment of the present invention.

Fig. 8 is an isometric illustration of a µPDA software vending machine in an aspect of the present invention.

Fig. 9 is a top plan view of a µPDA enhanced user interface according to an embodiment of the present invention.

Fig. 10 is a top plan view of a µPDA with a microphone in an embodiment of the present invention.

Fig. 11 is an isometric drawing of a µPDA docked in a
dedicated cellular or cordless telephone according to an embodiment of the present invention.

Fig. 12 is a plan view of a µPDA with a speaker and pager interface according to an embodiment of the present invention.

Fig. 13 is a plan view of a µPDA with an infrared communication interface according to an embodiment of the present invention.

Fig. 14 is a plan view of a µPDA with a scanner attachment according to an embodiment of the present invention.

Fig. 15 is a plan view of a µPDA with a fax-modem attached according to an embodiment of the present invention.

Fig. 16 is a plan view of a µPDA with a printer adapter interface according to an embodiment of the present invention.

Fig. 17 is an isometric drawing of a µPDA docked in a barcode reader providing a data acquisition peripheral according to an embodiment of the present invention.

Fig. 18 is an isometric view of a µPDA with a solar charger according to an embodiment of the present invention.

Fig. 19 is a plan view of four µPDAs interfaced to a dedicated network console providing inter-PDA communication according to an embodiment of the present invention.

Fig. 20 is an isometric view of a µPDA according to the invention connected by the expansion port to a standard-sized keyboard.

Fig. 21 is an isometric view of a portable computer and phone interface according to an embodiment of the invention.

Fig. 22A shows an opening menu screen in an embodiment of the present invention.

Fig. 22B shows a Caller Input screen for an embodiment of the invention.

Fig. 22C shows a Dial List screen for an embodiment of the invention.

Fig. 22D shows an Edit screen according to an embodiment of
the invention.

Fig. 22E shows a Setup screen for an embodiment of the invention.

Fig. 23A shows a sound enhancement device for an embodiment of the present invention.

Fig. 23B is a diagram showing internal functional components of the sound enhancement device of Fig. 23A.

Fig. 24 shows an external speaker attached to a portable computer in an embodiment of the present invention.

Fig. 25 shows a headset used as an external speaker in an embodiment of the invention.

Fig. 26 shows a physical interface for blocking external noise in an embodiment of the present invention.

Fig. 27 is a pictorial representation of an embodiment of the present invention comprising coded information transfer from one computer to another.

Fig. 28 is a matrix relating ASCII code to DTMF signals for the embodiment of the invention depicted in Fig. 27.

Fig. 29 shows a Data Transfer screen for selecting a data transfer mode from a scrolling list of modes.

Fig. 30 shows an exemplary message screen for one mode of message operation according to an embodiment of the invention.

Description of the Preferred Embodiments

Fig. 1A is an isometric view of a μPDA 10 according to an embodiment of the present invention. In this embodiment the unit is modeled on the PCMCIA standard Type II form factor, having a height D1 of about 5mm. Body 12 is described in further detail below, and has a female portion 14 of a connector recessed at one end for engaging a mating male portion of the connector in a host
computer, connecting the μPDA internal circuitry directly with a host internal bus. The host unit may be a notebook computer having a docking bay for the μPDA. Docking bays may be provided in desktop and other types of computers, and even in other kinds of digital equipment, several examples of which are described below.

Still referring to Fig. 1A, in this embodiment there is a combination I/O interface 16 implemented on one side of the μPDA, comprising a display overlaid with a touch-sensitive planar structure providing softkey operation in conjunction with interactive control routines operable on the μPDA in a stand-alone mode.

Although not shown in Fig. 1A, there may also be guides implemented along the sides of the case of the device for guiding the module in and out of a docking bay in a host computer unit. There may also be one or more mechanical features facilitating engagement and disengagement of the module in a docking bay.

Fig. 1B is a top plan view of the μPDA of Fig. 1A, showing a thumbwheel 18 implemented in one corner of the μPDA. The thumbwheel in this embodiment is an input device capable of providing input with both amplitude and directional characteristics, and in some cases rate characteristics as well. The thumbwheel has many uses in combination with the μPDA and I/O interface 16. One such use is controlled scrolling of icons, characters, menus, and the like on the display of the device. The thumbwheel provides many of the functions of a pointer device.

In this embodiment of the μPDA a second external connector portion 20 is provided. This connector portion is for engaging peripheral devices as part of an expansion bus interface.

Fig. 2 is a simplified cross-sectional view of a means for constructing a μPDA according to the present invention in a Type II PCMCIA, or other relatively small package. ICs 34 are encapsulated in a conformal material 36, and interconnection is accomplished by traces on a flexible polymer film 32 shown as overlaying the encapsulated structure. In this structure the ICs are not packaged in
the conventional manner having solder leads for assembly to a printed circuit board. Rather, connections are made directly between the solder pads on the chip and the traces on the Kapton film. Also there is no intention to relate ICs indicated by element No. 34 with specific functional ICs in a μPDA. This cross-section is illustrative of a method of construction only.

In this compact construction there may also be traces on the side of film 32 away from the interconnections for the CPU and memory for connection to other elements, such as display 25 and touch-sensitive screen 27.

LCD display 25 is implemented on one side of the μPDA, and touch-sensitive interface 27 is provided overlaying at least a portion of the LCD display. A metal casing 38, or other suitable material or combinations of material, surrounds the internal components and conforms to Type II PCMCIA form factors. This simplified cross-section illustrates some of the principles of construction that can allow the needed components to be inexpensively fitted into the small form factor needed. In another embodiment the μPDA is implemented in the form factor of a type III (10 mm thick) PCMCIA unit, using relatively conventional technology, such as PCB technology, rather than the encapsulated construction described immediately above. Various other constructions, form factors, and combinations are possible, as well.

Fig. 3 is a simplified electrical block diagram of the μPDA of Figs. 1A, 1B and 2. A unique microcontroller 11 acts as the CPU of the μPDA in the stand-alone mode, that is, when the μPDA is not docked in a host unit. When the μPDA is docked in a host computer, microcontroller 11 acts as a slave unit, granting bus control to the CPU of the host. In docked mode, the CPU of the host thus gains control of the memory contents of the μPDA, subject in most cases to security procedures which are described below. Thus the host computer can transfer data and software into and out of a docked μPDA memory. In other embodiments many other cooperative
operating modes may be accomplished between the two CPUs and accessible memory devices.

Memory 13 is preferably a nonvolatile device from 1 to 2 megabytes in this embodiment, and both control routines for applications and data files are stored in this memory. Memory 13 may be flash memory, CMOS ROM, CMOS RAM with battery, or a combination, with the software stored in ROM and the data in the flash memory. The memory device is interfaced to microcontroller 11 via a dedicated bus structure 17, and microprocessor 11 is configured to drive memory bus 17.

A battery 15 is the power source in the stand-alone mode, and may be recharged in one or more of several ways. The power traces are not shown in Fig. 3, but extend to all of the powered devices in the µPDA module. When the unit is docked in the host, the host power source may be connected to pins through the host interface to recharge the battery. Alternatively, an attached means such as a solar panel may be configured to charge the battery and/or provide power to the µPDA. A solar panel for power is described elsewhere in this disclosure. Also the battery may be easily removed for periodic replacement.

Host bus connector 14 is a part of a host interface which comprises a bus structure 26 for providing connection to the host in docked mode, as described above. In a preferred embodiment, the host interface is according to PCMCIA Type II, Rev. 3 standard, which is capable of communication either in PCMCIA mode or in a mode similar to PCI mode. PCI mode refers to a high-speed intermediate bus protocol being developed by Intel corporation, expected to become a standard bus architecture and protocol in the industry. The physical interface at the host in this embodiment is a slot-like docking bay, as is typical of know docking bays for PCMCIA devices. This docking bay may be implemented as a docking box, a built-in unit like a floppy-drive unit, or it may take some other form.
Connector portion 20 is a part of the expansion bus interface described above, comprising a dedicated bus structure 40 connected to microcontroller 11. This interface can be implemented in a number of different ways. The purpose of the optional expansion bus interface is to connect to optional peripheral devices, such as a printer, a FAX modem, a host cellular phone, and others. The expansion bus interface is not an essential feature in a minimum embodiment of the present invention, but provides vastly enhanced functionality in many embodiments.

The expansion interface can take any one of several forms. A preferred form is an extended enhanced parallel port and protocol based on an invention by the present inventors disclosed in a copending patent application. Another form is an indexed I/O port having 8-bit address and 8-bit data capability. The requirement of the expansion port is that the connection and communication protocol be compatible with expansion devices, such as telephone modems, fax modems, scanners, and the like. Many other configurations are possible.

Optional equipment such as devices listed in box 19 may be connected for use with the μPDA through the expansion bus. Selected ones of such devices may also be built in to the μPDA in various embodiments, providing variations of applicability. In the former case, connection is through path 21 and the expansion bus interface via connector portion 20. In the built-in case, connection is in the interconnection traces of the μPDA as indicated by path 23.

I/O interface 16 (also Fig. 1B) is for viewing μPDA application-related data and for touch-sensitive input via softkeys. By softkeys is meant assignment by software of various functions to specific touch sensitive screen areas, which act as input keys. Labels in I/O interface 16 identify functionality of the touch-sensitive areas in various operating modes according to installed machine control routines. LCD display 25 and the touch-sensitive area 27 together form the combination I/O interface 16 described also above.
In some embodiments of the present invention, data and program security is provided comprising an Electrically Erasable Programmable Read Only Memory (EEPROM) 31, which is connected by dedicated communication lines to microcontroller 11. EEPROM 31 holds one or more codes installed at the point of manufacturing to provide security for information transfer between a host and a μPDA. The purpose is to control access by a host to the memory contents of a μPDA, so each μPDA may be configured to an individual. To accomplish this, docking and bus mastering machine control routines are initiated at the point of docking, and this security process is described in more detail below. In other embodiments, security codes may be provided by a Read Only Memory (ROM) chip or other permanent or semi-permanent memory source.

Fig. 4 is a plan view similar to Fig. 1B, of a μPDA, showing in particular I/O interface 16. The size and location of I/O interface 16 may vary, but in general occupies a major portion of one of the sides of the module. In one embodiment I/O interface 16 comprises an LCD display with a resolution of 256 by 144 pixels in a screen size that displays 32 by 12 characters. Each character in this embodiment is displayed in an area eight pixels wide and twelve pixels high. In another embodiment, the pixel resolution is 320 by 200, which corresponds to 40 by 16 characters.

The touch-sensitive areas of the touch-sensitive screen correspond to the character areas of the display. By touching an area with a finger or stylus, data can be entered quite quickly and with minimal CPU demand.

At one corner, thumbwheel 18 provides a two-directional means of controlling the configuration of the display according to installed control routines. A menu 70 is configured at one side to represent the current status of any application in progress and to provide appropriate user menu selections. In a preferred embodiment input from thumbwheel 18 is used for scrolling through menu 70, and
active areas may be indicated by a cursor. A user makes a menu
selection by pressing the appropriate touch-sensitive area. A specific
input may be provided to cause the menu area to be displayed on
either side of the display according to a user's preference.

Specific characters are displayed in this embodiment in a
region 74, with each character area associated with a touch-sensitive
input area. As region 70 dedicated to selectable characters is much
too small to display all characters of a standard keyboard, input from
thumbwheel 18 allows a user to pan region 74 displaying an entire
virtual standard keyboard. Movement of thumbwheel 18 in one
direction pans the character region horizontally, and movement in the
other direction pans the character region vertically. When an end is
reached the window pans onto the virtual keyboard from the other
end. In this manner, a user may quickly pan the character window to
display an entire standard keyboard, and make selections with a finger
or a stylus. Of course, it is not required that a virtual keyboard be
laid out for access in the format of a standard keyboard. Characters
and punctuation, etc., could just as simply be displayed in a single
strip along a region of the display, and scrolled by input from the
thumbwheel or other pointer-type input device.

In this embodiment, to avoid delays caused by panning, if the
thumbwheel is rotated quickly the character window jumps rather than
scrolling to speed up the interface. In addition, menu 70 may
optionally provide for a character display in different fonts and sizes,
although a single font is preferred to minimize memory demand. It
will be apparent to those with skill in the art that there are many
alternatives for character selection and display, and many ways
thumbwheel 18 may be configured to allow for scrolling and panning.

A document window 72 is provided in this embodiment at the
top or bottom of I/O interface 16. A cursor locates the active position
within the document for editing purposes. Menu 70 provides selection
of available fonts, and input by thumbwheel 18 controls cursor
movement over the document. As a document will in almost all cases be much larger than the display capability of region 72, it is necessary to pan the document window in essentially the same manner as the keyboard window is panned. For example, rotating thumbwheel 18 in one direction may display horizontal strips of a document, while rotating the thumbwheel in the opposite direction moves the window vertically strips of the same document.

A soft key or optional hard key may be configured to switch between the document and keyboard window, and the same or another key may be configured to switch between scrolling left or right, up or down, document or keyboard. A switch key may be used to change the thumbwheel mode of operation. A switch key may also be used in combination with a floating pointer to select characters and menu items. In this embodiment, the user can keep his or her hands relatively stationary on just the thumbwheel and the switch key, making all possible selections. Use of a switch key in combination with a floating pointer facilitates the use of small fonts. A switch key may also be incorporated as an additional hard key in a convenient location on the case 12.

It will be obvious to a person skilled in the art that there are numerous ways to combine menu selections, switching keys and I/O configurations to provide a user-friendly user interface. A further embodiment of the present invention provides an I/O set-up application wherein a user may completely customize features of I/O area displays.

There are other sorts of mechanical interfaces which may be used to provide pointer-style input in different embodiments of the invention as alternatives to the thumbwheel disclosed. One is a four-way force-sensitive mouse button and a selector button, which may be located at opposite ends of case 12 below I/O interface 16. Each button is designed to be operated by one finger. The four-way force-sensitive mouse button can provide menu scrolling of a cursor
and panning and/or indexing of keyboard and document windows, while the selector button is used to select and edit according to position of a cursor. This configuration minimizes hand movement and keeps the I/O area clear for viewing.

Implementation of thumbwheels, pressure-sensitive switches and buttons, and the like, are known in the art, including the translation of mechanical motion and pressure to electrical signals and provision of such signals to a microcontroller. For this reason, details of such interfaces are not provided in this disclosure. Combinations of such inputs with displays and input areas may, however, be considered as inventive.

Fig. 5 is an isometric drawing of a µPDA 10 in position to be docked in a notebook computer 172 via a Type II PCMCIA docking port 105 according to an embodiment of the present invention. As further described below, once the µPDA is docked, it is activated and a procedure is initiated with the host computer to manage communication and verify memory access rights (security).

Access rights are considered important by the inventors for a number of reasons. Firstly, through the expedient of one or more specific codes, unique to each µPDA, a user may protect files stored in his module from access by unauthorized persons. The code can be used both to control access to data and files via I/O interface 16, and also through the host bus interface, so data and files may be secure from access by an unauthorized host system.

In the former case, when a µPDA is powered up, an application routine can query the user for an access code to be entered at I/O interface 16 (Fig. 4). If the code is not entered properly, access is denied, and power goes off. Codes for the purpose are stored in EEPROM 31 (Fig. 3), or in whatever ROM device may be devoted to the purpose. In some embodiments, the code may be mask-programmed at manufacture, so it is not alterable. In others, the code may be accessible and changeable by special procedures in the field.

In the case of host communication, it is possible that a portable
or desktop computer, or some other device, may have a docking port
physically configured to receive a μPDA, yet not be configured to
communicate with the μPDA. This certainly might be the case where
the μPDA is in the PCMCIA form. For purposes of disclosure and
description, this specification terms such a unit a generic host. If the
unit is configured to communicate with a μPDA it is an enabled host.
If a host is configured for full access to a particular μPDA, it is a
dedicated host.

If a docking unit is a generic host, there will be no
communication unless the person presenting the μPDA provides the
control routines to the host. This may be done for a generic host such
as by transfer from a floppy disk, from a separate memory card
through the docking port, or, in some embodiments, the
communication software may be resident in memory 13 (Fig. 3) of a
docked μPDA, transferrable to the host to facilitate further
communication.

If the docking unit is in fact an enabled host, or is configured
after docking to be an enabled host, the stored code or codes in
EEPROM 31 (or other storage unit) may be used to verify
authorization for data and program transfer between the host and a
μPDA. In one embodiment this procedure is in the following order:
First, when one docks a μPDA in a compatible docking port, certain
pin connections convey to both the μPDA microcontroller and to the
host CPU that the module is docked. Assuming an enabled host, the
fact of docking commences an initialization protocol on both systems.

In most embodiments, if the docking unit is a non-host, that is,
it is not capable of communication with the docked module, nothing
happens, and the user may simply eject the docked module. If the
computer is an enabled host, an application is started to configure host
access to the μPDA's data files through the μPDA microcontroller. A
user interface, described more fully below for a particular
embodiment, is displayed on the host monitor 104 (Fig. 5). The host
interface menu, as well as other application menus, may be formatted
in part as a display of the μPDA I/O interface 16 as seen in Fig. 4
and described in accompanying text. In some embodiments, the
docked μPDA can be operated in situ by manipulating the input areas
of the μPDA displayed on the host's screen.

If the host is not a home unit for the docked module, that is,
the host does not have matching embedded ID codes to those stored in
the docked module, a visitor protocol is initiated. In this event, a
visitor menu is displayed on host display 104 for further input, such as
password queries for selections of limited data access areas in the
docked module. In this case, too, a user may gain full access to the
docked module's memory registers by entering the proper password(s).

If the host is a fully compatible host home unit, full access
may be immediately granted to the host to access memory contents of
the docked module, including program areas; and both data and
programs may be exchanged.

In any case, when the μPDA is ejected or otherwise removed
from the docking port, the on-board module microcontroller again
gains full control of the internal μPDA bus structures.

Fig. 6 is a simplified block diagram of a μPDA docked in a
host computer, and Fig. 7 is a basic logic flow diagram of the steps
involved in docking a μPDA in a host computer 66 according to an
embodiment of the present invention. Host computer 66 is
represented in a mostly generic form, having a host CPU 24, and
input device 60, such as a keyboard, a mass storage device 28, such as
a hard disk drive, and system RAM 62. It will be apparent to those
with skill in the art that many hosts may have a much more
sophisticated architecture, and the architecture shown is meant to be
illustrative.

When a μPDA unit is docked, connector 14′ in Fig. 6
comprises portion 14 shown in Figs. 1B and 3 and a mating connector
portion for engaging portion 14 in port 105 (Fig. 5). The engagement
of the separate portions of the connector cause bus 26 in the μPDA
and bus 26′ in the host to become directly connected. There is then a
direct bus path between microcontroller 11 and host CPU 24 (Fig. 6).
As previously described there is a pin configuration (not shown) in connector 14 dedicated to signalling that a module is docked. In Fig. 7, step 42 represents insertion of a µPDA module into the docking port. At step 44 the signalling pin configuration signifies physical docking is accomplished. At step 46 host interface bus 26 is activated, including the mated host bus 26' in the host.

At step 48 (Fig. 7) microcontroller 11 in the µPDA starts a preprogrammed POST procedure. Microcontroller 11 in this embodiment has a page of RAM 68 implemented on the microcontroller chip. In other embodiments RAM may be used at other locations. At step 50, the POST routine loads a bootstrap program to RAM 68, which includes a code or codes for security matching. This code or codes comprise, for example, a serial number.

At step 54 the bootstrap program begins to execute in microcontroller 11, and at step 56 the microcontroller looks for a password from the host on host interface bus 26 (Fig. 6).

The fact of docking, assuming an enabled or dedicated host, also causes a communication routine, which may be accessed from, for example, mass storage device 28 at the host, to display a user interface on monitor screen 104 of the host unit, as partly described above. It is this communication program that makes a generic host an enabled host.

Assuming an enabled, but not dedicated, host, the user interface will query a user for input of one or more passwords, after successful entry of which the host will pass the input to microcontroller 11 for comparison with the serial number and perhaps other codes accessed from EEPROM 31 in the bootstrap of the µPDA.

According to the codes passed from the host to the docked module, microcontroller 11 will allow full access to memory 31 at function 52, Fig. 7, for the host CPU, or limited access at some level at function 58, defined by received codes (or no matching code at all).

The access protocols and procedures allowing partial or direct
access to μPDA memory 13 are relatively well known procedures in the art, such as bus mastering techniques, and need not be reproduced in detail here. In addition to simple comparison of codes, there are other techniques that may be incorporated to improve the integrity of security in the communication between a μPDA and a host. For example, within the limitation of storage capacity of the EEPROM or other nonvolatile source, executable code might also be uploaded to onboard RAM 68, or code keys to be used with executable code from other sources, or relatively simple maps re-allocating memory positions and the like, so each μPDA may be a truly unique device.

There are additional unique features provided in one aspect of the invention as part of the communication routines introduced above. One such feature is automatic updating and cross-referencing of existing files and new files in both computers, under control of the host system, with the host having direct bus access to all memory systems. Auto-updating has various options, such as auto-updating by clock signature only, flagging new files before transfer, and an editing means that allows the user to review both older and newer versions of files before discarding the older in favor of the newer. This automatic or semiautomatic updating of files between the satellite and the host addresses a long-standing problem. The updating routines may also incorporate a backup option to save older files.

Another useful feature in host/μPDA communication is a means for a user to select and compose a mix of executable program files for downloading to a μPDA, either replacing or supplementing those executable routines already resident. A user can have several different program lists for downloading as a batch, conveniently configuring the applicability of a μPDA among a wide variety of expected work environments.

Such applications as databases, spreadsheets, documents, travel files such as currency converters, faxing and other communications programs, time clocks, address and telephone records, and the like, may comprise customized lists of user-preferred applications.
In another embodiment, an undocked μPDA can transfer data via the optional expansion bus 40 (Fig. 3) directly to a host. In the special case of a μPDA user without access to a PCMCIA interface on his host (notebook or desk-top) computer, he or she can connect to a host via an auxiliary port on the host, such as a serial port, via the expansion bus interface. In this case, the μPDA still requests password(s) from the host, and controls access to its on-board memory according to the password(s) received.

The optional expansion interface may also be used in some embodiments while a μPDA is mastered by a host, wherein the host may effectively send data through the bus structures of the μPDA.

Additional Aspects and Features

Software Vending Machine:

In a further aspect of the invention, a Software Vending Machine with a very large electronic storage capacity is provided, wherein a μPDA user may dock a module and purchase and download software routines compatible with the μPDA environment.

Fig. 8 is an isometric view of such a vending machine 61 having a docking bay 63 for a μPDA, a credit card slot 65, and a paper money slot 67. A display 69 provides a user interface for reviewing and purchasing software from the vending machine, along with selector buttons such as button 71 along the sides of the display. In an alternative embodiment the display may also have a touch screen, and may, in some embodiments, emulate the μPDA I/O area on a larger scale.

In operation, a user may, in this embodiment, review software for sale simply by docking his μPDA unit in the vending machine and selecting from a menu on display 69. The menu may allow the user to browse all available applications, or list new applications since entered dates. The user can select certain applications, try them out,
at least in simulation, and then select applications to purchase.

The vending machine, once all the requirements are met, such as proper identification and payment, copies the selected application(s) to the memory of the μPDA, or, alternatively, to a floppy disk provided by either the user or the vending machine. In this case there is also a floppy disk drive 73 in the vending machine and a port 75 for dispensing formatted floppies for a customer to use in the disk drive. This mode is useful for the instances where a user’s μPDA is loaded beyond capacity to receive the desired software, or the user simply wishes to configure the software mix himself from his or her own host computer.

There may also be provided a backup option so a user may instruct the vending machine to read and copy all or a selection of his files to one or more floppy disks before installing new files or data.

As described above, each user’s μPDA includes an EEPROM or other storage uniquely identifying the μPDA by a serial number or other code(s), so the vending machine may be configured in this embodiment to provide the software in one of several modes.

A user may buy for a very nominal price a demo copy of an application, which does not provide full capability of the application, but will give the user an opportunity to test and become familiar with an application before purchase. Also, the user may buy a version of the same application, configured to the ID key of the μPDA to which it is loaded, and operable only on that μPDA. In another embodiment, the software is transferable between a family of keyed μPDAs, or has the ability to "unlock" only a limited number of times. In these cases, the applications would be sold at a lesser price than an unlocked version. The unlocked version works on any μPDA and/or host/μPDA system. The higher price for the unlocked version compensates for the likelihood of unauthorized sharing of the vended applications.

The vending machine could also offer a keyed version, customized to operate only on the μPDA docked in the software
venting machine, or upon a family of μPDAs. This keyed version is possible because of the individual and unique nature of each μPDA, which has, at a minimum, a unique serial number, and may also have other security programming, as described above, which allows a vending machine to prepare and download a customized copy of an application that will operate only on the particular module for which it is purchased.

There are a number of different means by which unique correspondence might be accomplished, as will be apparent to those with skill in the art. A standard version stored in the memory facility of a vending machine might be recompiled, for example, on downloading, using a unique code from the docked or identified μPDA as a key in the compilation, so only the specific μPDA may run the program by using the same unique key to sequence the instructions while running. The key for scrambling or otherwise customizing an application might also comprise other codes and/or executable code sequences stored uniquely in a μPDA.

In yet another aspect related to the vending machine, there is a printer outlet 77 which prints a hardcopy manual for the user. It is, of course, not necessary that the software vended be specific to the μPDA. Applications may also be vended for other kinds of machines, and transported in the memory of the μPDA, or by floppy disk, etc. In this embodiment a non-μPDA user can acquire a wide assortment of software.

The software vending machine may also serve as an optional informational display center in such locations as airports, train stations, convention centers, and hotels. Upon inserting a μPDA a user may interface directly and upload current information including, but not limited to, local, national, and world news; stock quotes and financial reports; weather; transportation schedules; road maps; language translators; currency exchange applications; E-mail and other direct on-line services.

A customized vending machine could be tailored to business
travelers and allow fast access to pertinent information, allowing the user to download files to send via E-mail. In another aspect of the invention, the vending machines are linked to each other allowing users to send messages to associates travelling through locations of associated vending machines. Such dedicated µPDA E-mail is immediately downloaded to a specific µPDA as it is docked. The sender may have the associate’s µPDA unique encoded key as identification, or some other dedicated identifying means for E-mail.

In another embodiment, as each business associate arrives at an airport, he or she may prompt the custom vending machine in that location via an optional installed infrared interface (not shown) in their µPDA. The custom vending machine, also equipped for infrared communication, receives the signal and sends/or receives any messages that are waiting.

Enhanced Display:

Fig. 9 is a plan view of an enhanced I/O interface unit 79 according to an aspect of the present invention. Interface unit 79, with about a 5-inch diagonal measurement, comprises a combination LCD display at least partially overlaid by a touch-sensitive input screen, providing an I/O area 80 in much the same manner as in a µPDA. Four docking bays 81, 83, 85, and 87 are provided in the left and right edges of interface unit 79 in this embodiment, and are configured for PCMCIA type II modules. One of these bays may be used for docking a µPDA according to the present invention, and the other three to provide a larger CPU, additional memory, battery power, peripheral devices such as modems, and the like by docking functional PCMCIA modules.

Interface unit 79 is a framework for assembling a specialty computer through docking PCMCIA units, including a µPDA according to the present invention. In other embodiments where the µPDA assumes other form factors, the docking bays may be
configured accordingly.

A docked µPDA in this embodiment is configured to produce its I/O display on I/O area 80. The thumbwheel on the µPDA is accessible while docked and acts as described above in the stand-alone mode in this case. In another aspect, the enhanced display has a re-configured output that enables the user to manipulate the data from the touch-screen alone and/or additional hardware selector buttons and/or a standard keyboard attached to the enhanced display via a dedicated bus port, or even through the expansion port of a docked µPDA. In a further embodiment the enhanced display has a dedicated mouse port and/or a dedicated thumbwheel.

In yet another embodiment, interface unit 79 has an inexpensive, conventional, replaceable battery and/or a rechargeable battery. Also, in another aspect, interface unit 79 may dock two or more individual µPDAs and cross-reference data files between them according to control routines that can manipulate mutually unlocked files. Further still, interface unit 79 may be placed and structurally supported for easy viewing on a dedicated standard or smaller-sized keyboard, connecting to the keyboard as an input device. The keyboard would then automatically serve as the input device.

Interface unit 79 for a µPDA is small and compact enough to slip into a pocket book or briefcase, providing a very portable, yet very powerful, computer.

Microphone/Voice notes:

Fig. 10 is a plan view of a µPDA 110 with an I/O interface 116, an expansion port 120, and a host interface connector 114. µPDA 110 has all the features previously described and additionally a microphone 88. In this embodiment, control routines in the µPDA use a linear predictive coding (LPC) approach to convert analog input from the microphone to a digital voice recording. This approach uses a minimum of memory, but still is capable of reproducing audio input
like the human voice within recognizable limits.

In an alternative embodiment, for better quality voice recording, a two-step integrator may be used in order to separate the analog signal and synthesize a closer digital representation.

With a μPDA so configured, a user’s voice notes can be recorded and later uploaded to a host for processing. In future embodiments the digital signals may be converted to text or sent as voicemail on a network. In yet another embodiment, the microphone is integrated with a speaker for editing purposes.

Cellular Telephone Interface:

Fig. 11 is an isometric view of a μPDA 10 docked in a dedicated cellular telephone 45 according to an embodiment of the present invention. Telephone 45 has a docking port 49 for a μPDA according to the invention. In this embodiment, port 49 is on one side of telephone 45, and there is a window 51 to provide access to I/O interface 16 of the μPDA after it is docked. With the μPDA docked, all of the software and memory of the μPDA is available to the telephone and a user may operate the phone by I/O interface 16.

In this aspect of the invention, unique control routines and display configurations are provided to enhance use of the cellular phone. For example, all of the user’s collection of phone numbers, associated credit card numbers, access codes, etc. are readily available and may be quickly and conveniently accessed and used. In one aspect, a simple input displays alphabet letters to select, and once a letter is selected, a partial list of parties that might be called is displayed. One may scroll through the list by touch input or by use of the thumbwheel of the μPDA and select a highlighted entry. It is not required that the telephone numbers be displayed.

Once a party to be called is selected, the μPDA dials the call, including necessary credit card information stored in the memory of the μPDA for this purpose.
In a further embodiment, the calls are timed and time-stamped and a comprehensive log, with areas for notes during and after, is recorded.

In another embodiment, conversations are digitally recorded and filed for processing later. A future embodiment may include a voice compression program at a host or within cellular phone 45. Compressed voice files, such as, for example, messages to be distributed in a voicemail system, may be downloaded into the µPDA or carried in a larger memory format inside the cellular telephone. The µPDA can then send the files via a host or dedicated modem attached at connector portion 20 to the optional expansion bus 40 (Fig. 6).

The cellular telephone may, in this particular embodiment, have a bus port for digital transmission. In this case, the compression algorithm along with voice system control routines are also established at the receiving end of the transmission to uncompress the signal and distribute individual messages.

In a further embodiment, voice messages may be sent in a wireless format from the cellular telephone in uncompressed digital synthesized form, distributing them automatically to dedicated receiving hosts, or semi-automatically by manually prompting individual voicemail systems before each individual message. In a further aspect of wireless transmission, a microphone/voicenote µPDA as in Fig. 10 may send previously stored voicenotes after docking in a cellular telephone interface.

In Europe and Asia a phone system is in use known as CT2, operating on a digital standard and comprising local substations where a party with a compatible cellular phone may access the station simply by being within the active area of the substation. In one aspect of the present invention, a CT2 telephone is provided with a docking bay for a µPDA, and configured to work with the µPDA. In yet another aspect of the invention, in the CT2 telephone system, and applicable to other digital telephone systems, a compression utility as disclosed
above is provided to digitally compress messages before transmission on the CT2 telephone system.

It is roughly estimated that a dedicated compression algorithm may compress ten minutes of voice messages into one minute using the existing CT2 technology. This would save on telephone use charges significantly. In this aspect, there needs be a compatible decompression facility at the receiving station, preferably incorporated into a standard μPDA voicemail system for CT2 or other digital transmissions.

In a further embodiment, control routines are provided to enable the microphone/voicenote μPDA as illustrated in Fig. 10 to carry digital voicenotes, either compressed or uncompressed. When docked in a CT2-compatible μPDA cellular telephone, the μPDA in this embodiment can transmit the digital voicenotes in compressed form.

**Speaker/Pager:**

Fig. 12 is a plan view of a μPDA 210 with a microphone/speaker area 90 and a pager interface 92 according to an embodiment of the present invention. This μPDA has the ability to act as a standard pager, picking up pager signals with installed pager interface 92 and alerting a user through microphone/speaker 90. Once the signals are received, μPDA 210 can be docked in a compatible cellular telephone as illustrated in Fig. 11 and the μPDA will automatically dial the caller's telephone number. All other aspects are as described in the docked mode in the cellular telephone.

In another embodiment, the speaker/pager μPDA can be prompted to generate DTMF tones. The DTMF tones are generated from a caller’s telephone number.

The speaker/pager μPDA can store pager requests in its onboard memory. It can also display all pager requests including time and date stamps, identification of the caller, if known, and other
related information, on I/O interface 216. In this particular
embodiment, a user can receive a page, respond immediately in digital
voicenotes on the μPDA via speaker/microphone 90, and then send the
response from a dedicated μPDA-compatible cellular telephone or
conventional telephone.

Wireless Infrared Interface:

Fig. 13 is a plan view of a μPDA 310 with an IR interface 94
according to an embodiment of the present invention. In this
embodiment the μPDA may communicate with an array of
conventional appliances in the home or office for providing remote
control. Unique signals for the appliances are programmed into the
μPDA in a learning/receive mode, and filed with user password
protection. Once a correct password in entered, an icon-based menu is
displayed on I/O area 316 in a user-friendly format. A master routine
first queries a user for which device to access. For example, in a
residential application, icons are displayed for such things as overhead
garage doors, security systems, automatic gates, VCRs, television, and
stereos.

In another aspect of the invention, a receiving station such as a
host computer or peripheral interface has IR capabilities to
communicate data directly from a nearby μPDA with an infrared
interface. In a further embodiment the μPDA may interface in a
 cellular network and act as a wireless modem.

PERIPHERALS

A μPDA may serve as the platform for various peripheral
attachments via expansion port 20 (Fig. 1B and others). Upon
attachment to a peripheral, a dedicated pin or pins within expansion
port 20 signal microcontroller 11, and a peripheral boot-strap
application is executed. Interfacing control routines, which may reside
in the peripheral or in the memory of the \( \mu \text{PDA} \), are then executed, and the \( \mu \text{PDA} \) I/O interface displays the related menu-driven options after the linking is complete.

**Scanner:**

Fig. 14 is a plan view of a \( \mu \text{PDA} \) 10 with a scanner attachment 55 according to an embodiment of the present invention. The scanner attachment is assembled to the \( \mu \text{PDA} \), making electrical connection via expansion port 20. In this embodiment the physical interface of the scanner is shaped to securely attach to the \( \mu \text{PDA} \). Scanner attachment 55 has a roller wheel 57 or other translation sensor, which interfaces with wheel 18 of the \( \mu \text{PDA} \), providing translation sensing in operation for the resulting hand-held scanner. In another aspect, scanner attachment 55 has a translation device which transmits the proper signal through expansion port 20. The scanner bar is on the underside, and one or more batteries 59 are provided within the scanner attachment to provide the extra power needed for light generation.

In the scanner aspect of the invention, scanner attachments 55 of different width D2 may be provided for different purposes. The bar may be no wider than the \( \mu \text{PDA} \), or may be eight inches or more in width to scan the full width of U.S. letter size documents, or documents on international A4 paper. Unique control routines display operating information on the \( \mu \text{PDA} \)’s I/O area 16 for scanning, providing a user interface for setup of various options, such as the width of the scanner bar, and providing identification for files created in the \( \mu \text{PDA} \) memory as a result of scan passes. Scanned data stored in the \( \mu \text{PDA} \) memory may be quickly transferred to the host via host interface 14 when the \( \mu \text{PDA} \) is docked. Unique routines may be provided to automate the process, so the user does not have to search for files and initiate all of the transfer processes.

**Facsimile Option:**
Fig. 15 is a plan view of a μPDA with a fax-modem module 89 attached according to an embodiment of the present invention. A fax and telecommunication capability is provided via conventional telephone lines to the μPDA by fax-modem 89 interfacing to expansion bus interface 20. The fax-modem has internal circuitry for translating from the bus states of the expansion bus to the fax protocol, and a phone plug interface 91. In another aspect, the μPDA can be docked in a host and be used in combination with fax-modem 89 to provide faxing and file transfers of both host and μPDA data files. In this case, the fax-modem routines are displayed on the host monitor.

Printer:

Fig. 16 is a plan view of a μPDA with a Centronics adapter interface according to an embodiment of the present invention. A printer connector 93 engages expansion interface 20 by a connector 95 through a cable 97. Translation capability resides in circuitry in connector 93, which is configured physically as a Centronics connector to engage a standard port on a printer.

Barcode Reader and Data Acquisition Peripheral:

Fig. 17 is an isometric view of a μPDA 10 docked in a barcode reader and acquisition peripheral 100 according to an embodiment of the present invention. μPDA 10 is docked in docking bay 149. I/O interface 16 displays information through opening 147 according to specialized data acquisition applications. In this particular embodiment peripheral 100 has an IR interface 94, a microphone 103, a scanner port 101 (not shown), battery pack 105, and a numeric keypad pad 96 implemented as a touch-sensitive array. Application routines enable the data acquisition peripheral to operate as, for example, a mobile inventory management device. The
user may scan barcode labels with scanner 101 and enter information, such as counts, on keypad 96 or by voice input via microphone 103. Since applications of peripheral 100 are very specialized, only a limited voice recognition system is needed. The voice recognition system may prompt other command routines within the master applications as well.

As inventories are collected, the database may be displayed and also manipulated directly via I/O area 16 in open bay 147, or information may be downloaded at a prompt to a nearby host via IR interface 94.

Alternatively to frequent data transmission, data may be stored or an auxiliary option memory location in peripheral 100.

In another aspect, the data acquisition peripheral may be interfaced to the analog output of a monitoring device, such as a strip chart recorder, and may digitize and store the incoming analog signals.

**Solar Charger:**

Fig. 18 is an isometric view of the side of a μPDA 10 opposite the I/O interface with a solar charger panel 98 according to an embodiment of the present invention. Panel 98 is positioned so that when μPDA 10 is in strong light, such as sunlight, the solar charger absorbs the solar energy and converts it to electricity to recharge battery 15 inside the μPDA. Solar charger 98 may be permanently wired to the circuitry of the μPDA or attached by other means and connected to a dedicated electrical port or the expansion port. The solar charger is placed so that the μPDA can be fully docked in a docking port with the panel in place. In another aspect, a detachable solar charger may be unplugged before docking the μPDA, and the detachable charger may then be of a larger surface area.
Games/Conference Center:

Fig. 19 is a largely diagrammatic representation of a Games Center unit 33 according to an aspect of the invention for connecting several ωPDA units (37, 39, 41, and 43) together to allow competitive and interactive games by more than one ωPDA user. Games Center unit 33 is controlled by an 80486 CPU in this particular embodiment. 

ωPDAs may be connected to the central unit by cable connection via the expansion bus or the host interface of each ωPDA, through a connector such as connector 35. The drawing shows four connectors, but there could be as few as two, and any convenient number greater than two.

As a further aspect of the present invention, the gaming center may serve as a conference center where a number of ωPDAs may exchange information. In this way, for example through custom routines stored and executable in central unit 33, a manager may update a number of salespeoples' ωPDAs, including but not limited to merchandise databases, spreadsheets, price sheets, work assignments, customer profiles, address books, telephone books, travel itineraries, and other related business information while in conference.

Standard Keyboard:

Fig. 20 is an isometric view of a keyboard 151 connected by a cord and connector 153 to a ωPDA 10 via the expansion port 20. In this example, the keyboard is a mechanical keyboard having a full-size standard key array and an on-board controller and interface for communicating with the ωPDA. In other embodiments the keyboard may take many other forms, including a two-layer, flexible, roll-up keyboard as taught in U.S. Patent 5,220,521.

In addition to keyboards, other input devices, such as writing tablets and the like may also be interfaced to a ωPDA via expansion port 20.
There are numerous additional ways to combine different embodiments of the μPDA for useful functions. For example, an IR-equipped μPDA attached to scanner 55 may transfer large graphic files in near real time to a host computer. If the files were of text, the host may further process the files automatically through an optical character recognition (OCR) application and send the greatly reduced ASCII files back to the μPDA. As discussed above, the μPDA family of devices establishes a protocol of software security and distribution as well as having the ability to be bus mastered by a host computer system for numerous applications.

**Computer-to-Telephone Interface**

The μPDA in embodiments of the present invention has uses in interfacing with telephone equipment, as is described in detail below, both for purposes of facilitating telephone communication, and for facilitating communication between a μPDA and other computer equipment over phone lines.

Dialer devices are used to generate Dual Tone Multi-Frequency (DTMF) audio signals that are transmitted over telephone lines and used to activate switching equipment to route phone calls. Small, portable dialer devices consist of an electronic tone generator coupled with a circular keying arrangement. They typically have a calculator-type integrated transistor circuitry and are encased with a sensitive microphone in a plastic holder. Such a dialer device replaces the transmitter element in a phone handset.

The top of the typical dialer has a set of push-button, Touchtone™ key pads which activate DTMF signals that cause automatic dialing of phone numbers. (Touchtone is trademarked by the American Telephone and Telegraph Company.) There are twelve key pads corresponding to the digits 0 through 9, the star symbol (*), and the pound symbol (#). Some dialers have four additional keys, designated A, B, C, and D.
The DTMF system of touchtone dialing uses internationally standardized combinations of frequencies. Table 1 is a matrix showing the high and low frequency pair, in Hz, required for each of the 16 characters in a full key pad configuration. Each character from the touchtone keypad is represented by a dual set of audio frequency signals, which when transmitted together are recognized by other electronic equipment as the unique representation of the keypad character.

<table>
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<th>Lower Frequency (Hz)</th>
<th>Higher Frequency (Hz)</th>
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<tr>
<td></td>
<td>1209</td>
</tr>
<tr>
<td>697</td>
<td>1</td>
</tr>
<tr>
<td>770</td>
<td>4</td>
</tr>
<tr>
<td>852</td>
<td>7</td>
</tr>
<tr>
<td>941</td>
<td>*</td>
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</tbody>
</table>

TABLE 1

Business persons have often carried the above-described dialer devices, also known as tone dial converters, to access their branch office computers from rotary (pulse) lines. Until recently tone dial converters were available from many phone outlet and hobby stores. Now that most public phone equipment has been converted to touchtone equipment, the use of these devices is not as common. However, the technology of DTMF tone conversion they perform may have other important applications.

Coupling one computer to another in a distant location usually
involves some form of modem. A modem is circuitry that modulates a carrier wave so digital data can be transmitted over an analog communications line, typically computer-to-computer over a phone line. Modulation alters one or more of the frequency, amplitude, and phase of the carrier wave with respect to time according to a known protocol related to the digital values. A receiving modem reconverts (demodulates) the carrier wave to digital data for use by another computer or computerized receiving device.

Primary types of modems are: voice-band - those that are used on voice-grade public phone lines (also known as dialup modems); acoustic coupler - those that permit a user to dial a phone number, listen for a signal from the other end of the line, and press the telephone receiver into two cushioned cups on the acoustic coupler; and direct connect - those that plug directly into the phone network.

Many times because of limited access to phone jacks in public places and the electrical connections required, it is difficult if not impossible for the user to set up a coupler or modem. It is not uncommon to spend more time making the necessary electrical connections than is spent actually transmitting and/or receiving data.

What is needed in these instances is a means of easily communicating by use of a portable computer, such as a µPDA according to an embodiment of the present invention, through a phone network without the need to set up a modem and physically secure a phone line connection. Also, the technology of converting DTMF tones is presently limited to that of the 16 keys on a phone touchtone pad. The expansion of DTMF tone conversion to include the entire ASCII code set would open the door to the transfer of computer code directly through such a portable computer-phone interface.

Fig. 21 is an isometric view of a notebook computer 1011 comprising an embodiment of the present invention. The general purpose computer system supporting the embodiment of the dialer
invention is conventional and preferably is in the form of a portable notebook, laptop, or palmtop computer, such as notebook computer 1011, or a µPDA as in the embodiments described above.

The enhanced control routines of the invention provide a user interface display 1016. A user can specify and select call numbers and other information by using keyboard 1017. Some portable computers have a built-in pointer device, such as trackball 1019, which selects menu items and moves a screen cursor on the interface display of the invention, more fully described below.

To make a call using this embodiment, the user activates the dialer applications by input to keyboard 1017. The user then selects a number to be called and initiates the call from interface display 1016. The invention’s control routines recall the user’s credit card information, previously programmed by in memory, and the selected call number. The system translates the digital data into the corresponding DTMF signals necessary to dial the number. The DTMF signals are those produced from a standard twelve-button touch-tone telephone key pad. The string of DTMF signals is output in this embodiment through the computer’s speaker 13 and are picked up through phone mouthpiece 21, held near the speaker, causing the call to be dialed.

The computer-driven "dialer" according to the present embodiment requires no line connection with the phone. The user simply holds the phone handset’s mouthpiece near the computer speaker to make the call. This provides "on-the-road" portable computer users with a capability to conveniently dial and communicate from phone booths, motel phones, and in other up-to-now impossible situations without the use of a modem. For the traveler the inconvenience of having to set up a modem with electrical connections into a telephone network often will preclude its use. Also most motel rooms and public phones do not have phone jacks. The dialer invention therefore presents a considerable advantage to the
computer user--there is no wiring setup required--and it can be used on any public phone without a phone jack.

An important feature of the embodiment shown by Fig. 21 is user interface display 1016, which provides a flexible interface to easily operate and edit variable information for the dialer. The interface is provided in this embodiment through menus as presented in Figs. 22A, 22B, 22C, 22D, and 22E.

Fig. 22A is a screen format for an opening menu in the present embodiment. The opening menu is presented when the dialer application is activated from the operating system by user signal. In the display, the user can point and select by moving a cursor 1041 with pointer device 1019 or by using the keyboard arrow keys to move the cursor and pressing the <Enter> or <Return>) key to make the selection. When the user selects a box having an entry field, the field is activated to accept keyboard input in the manner of an editor or word processor application. The mechanisms of these operations are familiar to those with skill in the art.

"Manual dial" box 1043 can be selected if the user wants to manually enter the number for a call. Entry field 1045 becomes active and displays the number entered. When the correct number is displayed, the user initiates the call by selecting "Click Here to Dial" box 1053.

For automatic dialing, the user is directed by message 1049 to use Dial List menu 1063 (as described below in Fig. 22C) to select a number to be called. Adjunct items on the opening menu (Fig. 22A) are date 1055, local time 1051, Help option 1057, and Exit option 1059. Other user aids may be provided in other embodiments as menu items.

Along the top of the screen of Fig. 22A are four menu selections--Caller Info 1061, Auto-Dial 1063, Edit 1065, and Setup 1067. These selections provide the user with means to quickly enter and change call information and the hardware setup. The user
accesses a menu by clicking with the mouse on the menu name or by typing the first letter of the name. Display screen initiated by selecting from the menu bar are shown in Figs. 22B through 22E.

Fig. 22B shows a CALLER INFO menu initiated by selecting 1061 in Fig. 22A, which lets the user specify or change his or her phone credit card information. The user selects one of the major carriers, such as "ATT," "MCI," or "SPRINT" in line 1069. In other embodiments the carrier list might be expanded. The system responds by automatically defining the carrier access number, which may be a 1-800 number, to be combined later with other data in dialing. If the user has a carrier other than the ones listed, he/she may select "Other" box 1071 and then enter the carrier access number in box 1072. The user enters his/her call credit card identification on "Credit Card ID" line 1073. A Help option 1075 is available. The user can abandon the menu and any changes made to its items at any time by selecting Cancel option 1079. The user selects OK option 1077 to save the caller information entered. The specified carrier access number and credit card identification remain in effect unless changed through the CALLER INFO menu in this embodiment of the invention.

Fig. 22C shows a DIAL LIST menu activated by selecting 1063 in the menu of Fig. 22A. This menu allows the user to display the list of phone numbers currently stored in computer memory and select a number to be called. The lists are accessed in this embodiment by call area code. The user first enters the desired area code on "Area code:" line 1081. In an alternative embodiment, area codes are displayed in a scrolling list, and the user may select from the list. The user can display the stored numbers for the selected area code either by phone number or alphabetically by name by selecting Display by Number box 1083 or Display by Name box 1085. Names and numbers are displayed in a scrolling list 1082 operated by a conventional scroll bar. Five phone number-name pairs are displayed numerically in order at a time. The name can be that of an individual
(last name, first name), company, or a code identifier—whatever the user chooses to identify the party to be called.

The user scrolls through the list by moving the up/down scroll arrows with pointer device or keyboard. The user then selects the number to dial and the selected number-name pair is highlighted. A Help option 1087 is available.

When the user is done with the DIAL LIST menu, OK option 1089 is selected. The screen may be exited without altering dial number selection by selecting Cancel option 1091. The system returns the user to the opening menu (Fig. 22A).

Fig. 22D shows an Edit menu activated by selecting 1065 in the opening menu screen shown in Fig. 22A, which allows the user to add, delete, or change phone numbers and names for a specified area code. The user first types the area code in "Area code:" line 1093. The EDIT menu allows the user to display by number or by name by selecting box 1095 or 1097. Five number-name or name-number pairs are displayed in scrolling list 1096.

To add a new pair, the user selects Add box 1099 and types the number and name in the "Phone number:" and "Name:" fields 1092 and 1094 respectively, and presses <Enter> or <Return>. The new number and name appears in order in scrolling list 1096.

To change a name and/or number, the user selects Change box 1101 and then selects the appropriate pair to be changed from scrolling list 1096. The selected pair will be highlighted and the number and name will appear in fields 1100 and 1102 below the Change box. The user then edits the information in the fields and selects <Enter> or <Return>. The change appears in scrolling list 1096. If a mistake is made in entry, the user just selects the number-name pair again and corrects it through the Change option.

A similar method is used to delete a number and name pair. The user selects Delete box 1105 and then selects the pair to be deleted in scrolling list 1096. The system will query in a popup
window whether the user really wants to delete the pair. The user can select "Yes" or "No." If "Yes" is selected, the pair will no longer appear in the scrolling list. The verification pop-up window is not shown here.

A Help option 1107 is available on the EDIT menu. Changes to the phone numbers and names can be abandoned at any time by selecting Cancel option 1111. To save all changes, the user selects OK option 1109.

Fig. 22E shows a SETUP screen initiated by selecting menu item 1067 in the screen of Fig. 22A, providing a means for the user to define the particular hardware setup he/she will be using in conjunction with the dialer application of the invention. The user can select from three computer-phone configurations. Selecting box 1113 sets the mode to use the invention's tone dialer with a computer having a built-in speaker. Selecting box 1117 allows the user to use a conventional modem-phone connection with touch-tone dialing; and selecting box 1119 allows the user to utilize a conventional modem-phone connection with pulse dialing.

One additional mode, selected by box 1121, to be discussed in detail below with reference to Fig. 27, comprises a means to send computer-recognizable code to a computer in a remote location. Help 1125, OK 1127, and Cancel 1129 are available on the SETUP menu.

Many portable computers have adequate built-in speakers to accomplish the function of the invention, which is to output DTMF tones through a speaker to activate telephone switching equipment. However some computers have inferior quality built-in speakers. An additional embodiment of the invention comprises a sound enhancement device 1133 as depicted in Fig. 23A. Device 1133 is configured to be placed over the computer's built-in speaker 1130. A suction cup interface or other convenient unit 1131 may be used between the sound enhancement device and the computer so the device makes a snug fit against the computer's speaker. Fig. 23B is a
schematic diagram showing the principal components of the sound enhancement device. The sound enhancement device picks up DTMF tones from the computer speaker tones through a microphone 1135, sends the tones through an amplifier circuit 1137, and provides enhanced signals to the device’s high-quality output speaker 1139.

If the computer does not have a speaker, another embodiment of the invention, shown in Fig. 24, provides an external speaker 1144 to be connected with sound jack 1141 and cable 1143 through the computer’s audio output port 1142. Alternatively, as shown in Fig. 25, a sound jack 1146 and cable 1147 could connect a computer’s audio output port 1145 to a headset attachment 1148 to serve as the speaker.

To block out extraneous noise, a secure fit of the external speaker with the phone mouthpiece is desirable. This can be achieved, as shown in Fig. 26, by adding an interface 1151 to external speaker 1149 so the speaker can be firmly interfaced to phone mouthpiece 1153, thereby mitigating external noise at the interface. This additional feature is desirable when using phones in busy, high noise environments such as airports, conference rooms, or phone booths on a busy street.

In a further embodiment, control routines provide a unique means for sending code in DTMF tones from a portable computer and telephone interface 1157 as described above, over phone lines 1148 to a computer 1161 in a remote location, as shown in Fig. 27. The remote unit in this embodiment has decoding ability to accept the DTMF tone-based data from a phone line and translate it into a digital representation interpretable as American Standard Code for Information Interchange (ASCII) computer code. Fig. 28 provides a matrix that shows the DTMF tone values assigned to each character in the ASCII set. A decoder is implemented in the remote unit in this embodiment for receiving input DTMF data. The decoder can be implemented by an add-on card connected to the computer bus and to
the phone line by a phone jack 1159.

In the data-transfer embodiment the user selects box 1121 in the screen of Fig. 22E, and the system then displays a selection screen shown in Fig. 29. The selection screen has a scrolling list 1163 of formats for data transfer, each unique to a particular purpose. Such formats may be furnished with dialer applications in this embodiment, or, in alternative embodiments, an editor may be provided for creating new applications.

An example of a data transfer format is message format 1165 in the scrolling list of Fig. 29. To implement this format the user selects the format, which is then highlighted in the scrolling list, and then selects "OK" box 1166. The system then displays the message format screen shown in Fig. 30. In this message format, the system provides the user with an active scrolling entry field 1167, wherein text may be entered in the manner of a text editor or word processor. There is a check box 1171 for activating an entry field 1175 to enter a filename for the message, to be stored as that filename at the receiving station. There is additionally a checkbox 1173 for activating an entry field 1177 to enter a recipient ID or destination for the massage, which may be decoded and used at the receiving end to direct the message to a specific recipient. When the user is satisfied with the text to be sent and other input, selecting "OK" box 1169 displays opening menu shown in Fig. 22A. The user simply selects the number and dials as in other embodiments. When the number is dialed and the connection made, if the "Remote Unit" selection is active in the screen shown in Fig. 22E, the system will transfer the text by DTMF code according to the table of Fig. 28.

In this embodiment it is required for successful data transfer that the remote unit have a receiving modem to decode the incoming DTMF tones and provide the resulting data on the receiving computer's bus. The modem has a receiver capable of interpreting two simultaneous DTMF tones, a processor for managing operations,
and a look-up table according to Fig. 28, as well as control routines for directing the CPU in managing the modem.

There are an infinite variety of dedicated transfer applications that may be implemented in the data transfer mode of the invention, and the message mode is but one of these. There are many others, such as data entry to databases, such as order forms and the like, that would be equally useful.

It will be apparent to one with the skill in the art that there are many changes that might be made and many other combinations that might be made without departing from the spirit and scope of the invention. There are, for example, many ways to implement the support structure of the μPDA, and to interconnect the active components. One way has been illustrated by Fig. 2 and described in accompanying text. There are many alternatives to this preferred structure. There is also a broad range of sizes and form factors that might be assumed by devices according to the present invention. The use of well-known PCMCIA form factors has been disclosed, but other sizes and forms might also be provided in alternative embodiments. In larger embodiments, on-board peripherals may be implemented.

In addition to these alternatives, there are various ways the connectivity of a μPDA bus might be provided. The well-known PCMCIA standard has been disclosed as a preference, but other connectivity may also be used in alternative embodiments. Memory types and sizes may vary. Means of providing a security code may vary. The nature of the internal bus may vary. There are indeed many variations that do not depart from the spirit and scope of the invention.

In the computer-to-telephone interfacing aspects of the invention, provisions have been made for a computer without a speaker or one with an inferior quality speaker, where, in the first case, an external speaker attachment is added and, in the second case,
the external speaker and phone are interfaced with a special gasket fitting to decrease external noise around the output speaker, thereby improving the quality of the dial signal. Another embodiment extends the invention concept to enable the dialer invention to send computer code over phone lines to a remote computer, as described above. This alternative could feasibly be extended further to provide remote commands and other input to a remote computer to provide a wide variety of tasks. The ASCII/DTMF matrix is also just one of many such matrices that might be used to relate the two forms for data transmission within the spirit and scope of the invention.
What is claimed is:

1. A personal digital assistant module, comprising:
   an enclosure for enclosing and supporting internal elements;
   a microcontroller within the enclosure for performing digital
   operations to manage functions of the personal digital assistant
   module;
   a memory connected to the microcontroller by a memory bus
   structure for storing data and executable routines;
   a power supply within the enclosure for supplying power to
   functional elements;
   a touch-sensitive display operable by the microcontroller and
   implemented on a surface of the enclosure;
   a host interface means comprising a host interface bus structure
   connected to the microcontroller and to a first portion of a host
   interface connector at a surface of the enclosure, the host interface
   means configured to directly connect the microcontroller to a
   compatible bus structure of a host computer; and
   a telephone dialing and communication system wherein
   telephone dialing data is stored in the memory, a menu-driven
   interface is implemented on the display with functions for a user to
   select call destinations and to combine data from the memory
   according to selected destinations, and a speaker for generating dual-
   tone multiple-frequency (DTMF) signals according to the data\ to dial
   touch-tone phones and to send DTMF-coded data over the phone
   lines.
Insertion of Module → Docking Verified → Host Bus Activated → Start POST Procedure → Bootstrap Program Loaded to RAM → Bootstrap Program Executed → Program Looks for Signature From Host → Do Codes Match?

Yes → Full Data Access Granted

No → Limited Data Access Granted

Fig. 7
Fig. 22D
DATA TRANSFER

Message 1
Message 2
Order Entry 1
Order Entry 2
Data Base Entry
Command List

HELP  OK  CANCEL

Fig. 29
Message 1:

This is an example of a message that might be sent to a remote computer by means of DTMF tones corresponding to ASCII characters.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G06F 3/023, 15/163, 15/17; H05K 5/04; H04L 1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)


Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Please See Extra Sheet.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<td>Y</td>
<td>US, A, 4,545,023 (Mizzi) 01 October 1985, Fig. 4 and col.s 1-2.</td>
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<td>Y</td>
<td>US, A, 5,133,076 (Hawkins et al.) 21 July 1992, Fig. 2B and col.s 1-2.</td>
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<td>US, A, 4,849,674 (Cherry et al.) 18 July 1989, col.s 1-4.</td>
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<td>Y</td>
<td>US, A, 4,748,656 (Gibbs et al.) 31 May 1988, Fig. 1 and col.s 1-2.</td>
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<td>US, A, 5,029,183 (Tymes) 02 July 1991, Fig. 1 and col.s 1-4.</td>
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<tr>
<td>Y</td>
<td>US, A, 4,534,012 (Yokozawa) 06 August 1985, col. 1, line 67-col. 2, line 63.</td>
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*X* Further documents are listed in the continuation of Box C. | See patent family annex.

T: later document published after the international filing data or priority data and not in conflict with the application but cited to understand the principle or theory underlying the invention

X: document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y: document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

P: document member of the same patent family

Date of the actual completion of the international search

19 OCTOBER 1995

Date of mailing of the international search report

01 FEB 1996

Name and mailing address of the ISA/US

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Form PCT/ISA/210 (second sheet) (July 1992)
**INTERNATIONAL SEARCH REPORT**

### C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>Y</td>
<td>US, A, 4,016,542 (Azure) 05 April 1977, col.s 2-4.</td>
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<td>Y</td>
<td>US, A, 5,210,854 (Beaverton et al.) 11 May 1993, col.s 2-3.</td>
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<td>US, A, 5,164,982 (Davis) 17 November 1992, Fig.s 1-9 and col.s 3-5.</td>
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<td>US, A, 5,335,276 (Thompson et al.) 02 August 1994, Fig. 1 and col.s 2-5.</td>
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<td>Y,P</td>
<td>US, A, 5,365,577 (Davis et al.) 15 November 1994, Fig. 1 and col. 3, line 62-col. 4, line 42.</td>
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Form PCT/ISA/210 (continuation of second sheet)(July 1992)*
### INTERNATIONAL SEARCH REPORT

**A. CLASSIFICATION OF SUBJECT MATTER:**

**US CL:**

395/200.2, 280, 800, 275, 427, 155; 345/160, 169, 173; 379/93, 96; 364/709.09; 320/21

**B. FIELDS SEARCHED**

Electronic data bases consulted (Name of data base and where practicable terms used):

- APS: digital assistant#, keyboard#, display?, monitor#, data terminal#, computer terminal#, CRT, controller#, microcontroller# or micro(w)controller#, interfac?, bus?, power supply, processor# or microprocessor# or micro(w)processor#, speaker#, interactive or menu-driven, telecommunication# or tele(w)communication#