

# A Context-Aware PDA

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## Abstract

*The PDA without context awareness capability might "provide anything anywhere and at anytime" through wireless network services and applications. But we focus on "providing right things at a right time in right ways". In this paper, we present a hardware and software platform of context-aware PDA including a GPS sensor that is adapted to receive location information, and several context-aware applications that are designed to provide users with suitable reminder messages.*

## 1. Introduction

The information appliance (IA) has grown fast since 1978. It is an appliance that focuses on "information" such as knowledge, news, pictures, images, videos, audio, and other special functionality. However, we have found that the development of IA products focuses on traditional computer applications and products such as thin clients, Net TVs, screen phones and PDAs. It is difficult to get rid of traditional computer operation styles. Therefore, it is not easy to get involved in the popular and to join in the daily life.

From the above reasons, a consensus of improving information appliances and creating smart appliances is being formed gradually now. What kind of device can be a smart appliance and what capability should it have? Here is a definition [11]: "Smart devices are ones that are not ignorant about their environment and context." In order to monitor the surrounding and status changing at anywhere and at any time, the context-awareness is the core technology of smart appliances.

The concept of context-awareness or context-aware computing was presented dating back to the mid-'90s [1][2] and it becomes the major capability of ubiquitous computing [4][6]. In the beginning development, the applications were focused on location-aware devices [3][7]. However the range of the context definition is very wide and it keeps not only the location data, but also status, environment, conditions, and tasks of the surroundings. In the project of TEA [20], it gives us a definition: "Context awareness is knowledge about the user's and device's state, including surrounding, situation, and location." In order to present those contexts correctly, the

sensor technologies play a major role in context-aware computing. Therefore, a branch of these technologies field, which is called sentient computing or sensor-driven computing, was formed in the end of 1990s[16]. The definition of sentient computing is "it can change their behavior based on a model of the environment they construct using sensor data."

In the recent definition of context awareness given by Dey and Abowd in 1999, they pointed out that "the context is any information that can be used to characterize the situation of an entity, where an entity can be a person, place, physical or computational object." The technology of context awareness is "the use of context to provide task-relevant information and/or services to a user, wherever they may be." Under those concepts, we can distinguish this field from "smart device" [8][9][12], "smart environment" [14][15][18], "smart communication" [5][13], and "smart application" [10][19][21][22].

Comparing with the traditional information appliances that only have the capability of network linking, the smart appliances have not only the smart communication to interact with users and devices, but also the intelligence by sensors. Therefore, the smart appliances are more friendly and convenient.

The Embedded System Lab of Institute for Information Industry (III) [24] recently made some achievements on developing a new PDA with context awareness that combines functions of handheld companions and vertical application devices. This paper will present the design of software and hardware platform for this integrated system.

## 2. Hardware Platform

For portable devices, there is a need to integrate all hardware components and IC chips into a single box as well as possible. The design of hardware is centered by a MPU SoC that has a built-in ARM7 core and some peripheral controllers such as UART, SDRAM, LCD, etc.. Serial interfaces to IrDA, USB, and COM ports are for communication. A Compact Flash interface is provided for mini data storage cards. A LCD display is STN 256 color with 320x240 pixel resolution. A microphone device is an interface for voice recording and an audio device is for playing MP3 music decoded by the centric SoC. A user input interface includes a touch panel and 5 keys. Finally, the power is supplied with a 3.6V Li-ion battery that has the same size of those for Motorola mobile phones; users also can connect cars' power converters to a device with 6V DC power. The hardware block diagram is shown in Fig. 1.

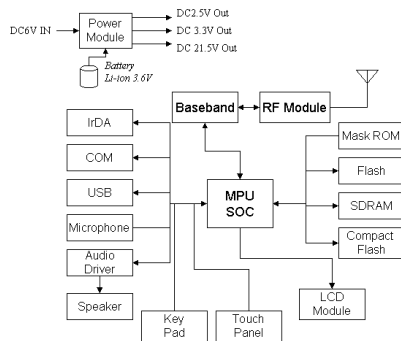


Fig1. Hardware block diagram for the portable navigation system

Palm size and lightweight devices provide mobile flexibility. Excellent power managers present long standby time. An extended GPRS/GSM module (or Mobile Equipment, ME) that uses standard Hayes AT control commands with some extra AT commands needed to set up their GPRS connections is included for wireless telephony communication. Prototypes from evaluation modules to products named as *PS-168* are shown in Fig.2 or reference to ProSense Inc. Web site. [23]

A build-in GPS (Global Position System) receiver is an imported sensor in our hardware platform. GPS receivers convert SV signals into position, velocity, and time estimates. Four satellites are required to compute the four dimensions of X, Y, Z (position) and Time. GPS receivers are used for navigating, positioning, time telling, and other research. GPS provides specially coded satellite signals that can be

processed in a GPS receiver, enabling the receiver to compute the position, velocity and time.



Fig. 2. An ARM based product prototypes. (*PS-168*)

## 3. Software Platform

The major software components developed in III include an embedded operating system, a compact window system, mini communication protocol stacks, and an integrated software development environment. The micro kernel is named TICKERS, which is specifically designed for customized embedded systems to utilize general-purpose processors with specialized hardware for application-specific functions. The micro window system is basically a graphical user interface with a compact size that supports small display, limited user interface resources for smart handheld devices. The combination of TICKERS with the compact windows is named @VIS as shown in Fig.3.

The dynamically downloadable and Java enabled mechanism provides functionalities for featured expansion. On the other hand, in order to provide application programmers with a good environment, we also have developed a compiling environment, debugging tools, and an emulator. These are integrated together with commercial software such as Microsoft Visual Studio and Boland C++ Builder. Open SDK can

provide interested programmers with an application development environment and reference. Due to limited resources of device hardware and the need of network communication, we have developed mini size TCP/IP and PPP stacks.

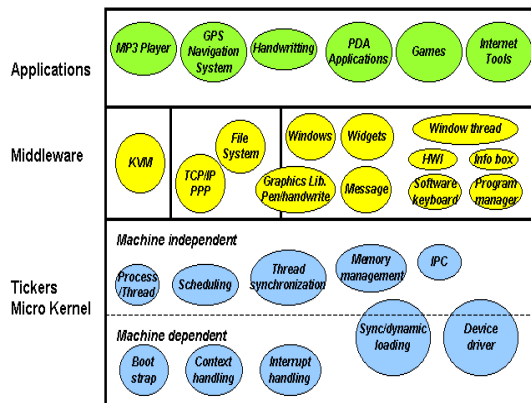


Fig 3. The micro kernel, middleware, and software components inside the @vis.

A package called SmartSync performing data synchronization functions is also provided. This package resides between Microsoft Outlook on desktop PC and PIM on PDAs. It's very convenient for business people. Data exchange protocols, including VCard & VCandler, are also supported. A friendly user interface gives the owner an easy-to-use operating environment.

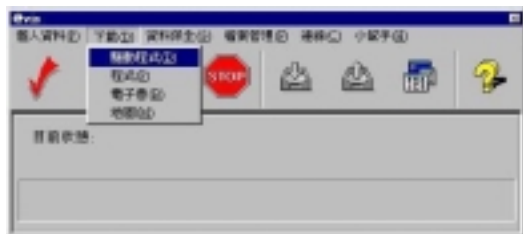


Fig 4. The @vis SmartSync integrated environment.

#### 4. Context-Aware Application

Our context-aware PDA can recognize the user's situation and provide useful information to the user. Important aspects of the user's situation might include locations, time of a day, tasks and needs of privacy.

The user interface of GPS/GIS is shown in the Fig5. Relying on the GPS sensor, a lot of applications can be done with the GIS (Geography Information System) map that is stored in the CF extending card module. For example, when a user puts the PDA on the car and drives it to somewhere, the PDA will display

the user's location and the path on the map to help the user to know where he/she is.



Fig 5. The user interface for GPS function

The context-aware PDA not only provides the standard satellite car navigation system but also integrate with PIM (personal information management) applications such as "to-do list", "schedule". A context awareness manager is used for context event manipulation. The context awareness manager manages an event link-list. The PIM applications add a notify event if needed by user input. The context awareness manager will collect the sensor data and find the matching location with the event link-list.

For example, if a user inputs data as "Drink coffee at the Starbucks in the afternoon" in the "to-do list" application, the key word "Starbucks" will be notified as a user event in the context awareness manager's database. The context awareness manager collects location data from GPS sensors and compares the notification events database with the location data period. When a match is found, a dialog or message box will display to remind the user. In this case, when the user is around the "Starbucks", a dialog will show up and display the "Drink coffee" message.

A security secretary is another context-aware utility to protect car owners. When a user leaves the car, he/she can setup the security secretary into protection mode. The context awareness manager will receive an event notify from this security secretary and enable an event notify flag for matching process. When the car is moved by something or someone without protection disabled, the security secretary will send a short message through GSM wireless service to the car owner. The message includes the location and time. The car owner can get back his/her car by that information.

## 5. Summary

The PDA without context awareness capability might provide anything, anywhere at anytime through wire/wireless network service. But other design point we focus on is to provide right things at right time in right ways. We've designed a context-aware PDA prototype to achieve this concept.

The PDA we design has the standard equipments of PDA such as palm-size appearance, a wireless extending module, and a CF card interface. We also add a GPS receiver as a location sensor to detect the location information. Several context-aware applications are designed by picking the data of GPS and GIS. In this paper, we also present the instances of those applications.

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