A PDA-based Mobile Profiling System for Customized Learning

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Abstract: With recently increased emphasis on learner-centered education, a u-learning system, which provides learners with individualized learning, has been becoming the focus of attention. Also, the advance of technology enables learners to have easier access to the Internet through PDA or Smart Phone, thus to acquire information needed to learn on the spot at the moment without time or space constraints. So, what matters now is how learners obtain and access information suitable for them. To that end, some efforts are already underway. Joining the efforts, we shall propose a PDA-based profiling system, which takes into account circumstances of a learner with specifications on a mobile device and learners' levels or preferences for customized learning. The system is devised to provide the information of a mobile device as well as the information of a learner's profile.

Key-Words: U-learning, PDA, Learner-centered education, Individualized learning, Mobile profiling system

1 Introduction

Unlike face-to-face school education, web-based education systems enable learners to learn in any place at any time and to have self-directed learning. However, they haven't yet been developed into a learning aid, which reflects learner differences such as degrees of knowledge, learning capability and learning goals thus making possible customized learning [5]. For this reason, these systems have activities made based just on inexact learning preferences of a learner and without doubt aren't supporting effectively learners for active and customized learning.

However, as progress in information technology has encouraged the spread of mobile handsets, the attention to a mobile learning supporting system has been increasing. Because the information from a mobile handset can be more specific and detailed than one from desktop computers, learning through mobile handsets is more suitable for customized learning [3,4].

In this paper, we shall suggest an information processing system in relation to the development of the customized learning system for mobile learners. Our system provides a server with PDA, GPS, RFID and learner input data. The information serves not only as a good evidence in knowing a software & hardware interface environment, a physical & logical environment, but also as a determining guide for learners' learning styles, goals, and levels.

2 Background

In a traditional class, it is difficult to put in practice learning, which suits a learner's level, and individualized learning, which allows for a learner's learning style. That is because the learning environment such as learning material, learning hours, and learning methods makes difficult learning, which fits individuals' levels or styles. As a result, each learner ends up being in an inappropriate environment for their levels and has ineffective learning. In contrast to off-line learning where information of each learner is hard to be considered, it's possible in on-line one and when mobile handsets are used for interface, it is also plausible to have customized learning which takes account of learners' levels, learning styles or learning environments.

Customized learning is a class model, which in accordance with the principles of individualization tries to differentiate itself from the existing one. It is an individualized methodology in contrast to lecture-based classes and a teaching method which

puts learning goals in hierarchical order and let a student learn according to one's level and diagnoses a learner based on one's level through diagnostic evaluation [6].

Also, it is required to apply the standardization of learner's profile information in order to enable customized learning that reflects on the personal characteristics. The standardization of learner's profile information helps in providing the differentiated learning service to learners by enabling that the learning histories from the various learning providers are managed in integrated form [1,2]. We construct the learner's profile information based on learner's diagnostic and learner's profile standardization model.

3 The Structure for Customized Service

Our system is devised to provide a more elaborate customized learning environment by making a mobile device profile with information about learners, specifications on mobile devices, GPS information indicating a learner's location, and RFID information. As illustrated in Figure 1, the system is made up of two components; a server part, which offers learning services and, a client part which PDA among mobile devices takes up. The use of PDA does not mean that a common mobile phone cannot be utilized as the client of the system, but that PDA is the optimal mobile device, which satisfies such requirements as GPS or RFID information, and a user's interface environment considering a mobile device's capability.

The client has 'Profile Collector/ Encoder' that collects and encodes a learner's information from 'mobile user interface', GPS & RFID information, and PDA specification information from PDA system.
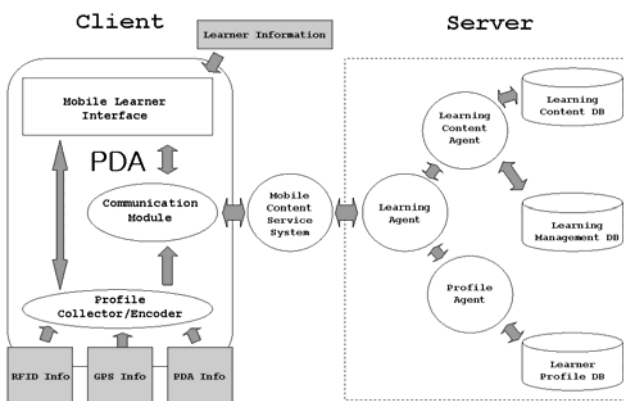
The mobile device profile processed in this way will be sent to a server through 'Module Communicating with Agent'. Some of the profile data are saved in 'Learner Information Database' in the server, and some of them are sometimes changed in the learning process. Based on ' Learner Data Database', 'Profile Agent' controls learner profiles which should be kept through many learning sessions. 'Learning Agent' receives such information as learners' levels or preferences, goals, learning hours, and learners' locations from a mobile device and 'Profile Agents' constructs a customized learning environment for a learner [7, 8].

Learning data are saved and managed in 'Learning Material Database', and metadata about learning data such as relations between learning data and knowledge structure in 'Learning Management Database'. 'Learning Data Database' is a database, which includes learning data available on the web. 'Learning Data Agent' plays a role of a search engine for the two databases. 'Learning Agent' extracts a diagnostic questionnaire or optimal learning data and send them to the client using 'Learning data Agent' in cases that a learner diagnosis is needed or a customized learning environment should be provided based on learners' levels, preferences, objectives, etc.

Figure 2 represents MCSS structure located conceptually in the middle of PDA client and application server. MCSS consists of three components: Device Profile Manager, Gateway, and Transformer. Device Profile Manager has the role of providing the details of various mobile devices. Transformer translates the learning contents form the application server into the customized contents corresponding to each mobile device. Gateway communicates with a client using a socket interface.
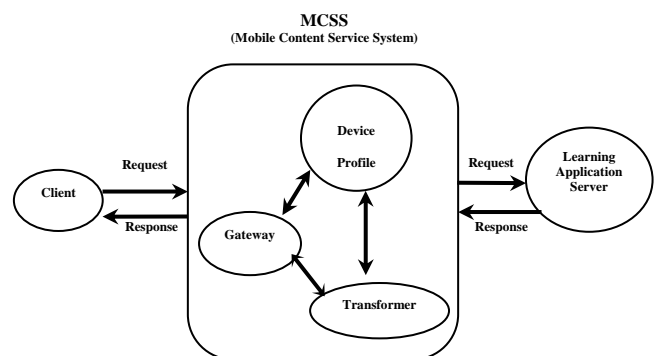

Fig.1. The Overview of the System

Fig. 2. The detailed MCSS

3.1 An Example of Service for Learning

Now, we'll describe a typical learning scenario based on the service system mentioned above. Learner L wants to learn using a PDA at some place. As the first step, L can make a diagnostic of his/her learning level and submits the diagnostic data to the server, which returns the diagnostic result about L. Also, Profile Collector/Encoder collects and encodes the learner profile from PDA itself, GPS, RFID reader, and the learner, and then sends it to the server. Now, L can be provided with a learning service suitable for his/her PDA and learning level.

The high portability of a mobile device is very helpful in learning because it would be possible for the device to bring a learner into a u-learning environment. However, if we couldn't consider the characteristics of the PDA which may have many restraints such as screen size, performance, and power consumption, the learner L would be served with non-customized learning contents. As a result, it could degrade the learning effect.

We also propose the approach to apply the RFID information to learning including the basic profile information. For example, we can assume that the learner L goes to the museum for study and the articles in the museum have RFID tags themselves. L reads the RFID tag of the article of interest using the tag reader attached to the PDA. After reading it, on the spot, L can get additional learning information about the article such as motion learning or hypermedia-based learning contents provided by his/her instructor on the Internet. Under this situation to learn on the spot, it is very important to provide a customized learning service to L using the profiling information. As another example, situation learning is necessary for L, who is interested in learning English as a foreign language. If each object in any place has a RFID tag, L who wants to know its expressions, can read it using a RFID reader attached to PDA. Then, the information of the RFID tag will be sent to a server database to get the English expressions corresponding to the tag.

4 Encoding Profiling Information

In this system, a mobile device profile is sent encoded as a part of HTTP header, and Table 1 shows the encoding scheme.

Table 1. Profile Encoding Form and Example

Variable	Value
HTTP_USER _AGENT	AABBCCCCDDDDDDEEEEFF;GGHHIIJJKK;LLLLLL.LLLMMMMMMNOOOO.OOOOPQQQQQ.QQQQ;R
HTTP_USER _AGENT (Example)	HP01CE10240320200704;2430162331;232221.015311204N3558.0468E12657.5067;R

Profile data collected from a mobile device are sent in the form of a variable HTTP_USER_AGENT. Fields composed of the encoded values are divided into 4 main parts. Each part is split by a semicolon and recorded in the following order; PDA profile, Learner Information, GPS Information, RFID information.

Table 2. PDA Information Encoding

Type	Description	Set Value	Remark
String	Device Manufacturer	AA-ZZ	Total Fifteen Manufacturer's Information
Digit	Device Model from Different Manufacturers	01-99	Model Number
String	OS Version	AA01-ZZ99	OS name and version
Digit	The number of pixel of each width and length in LCD	$0\sim999 \times 0\sim999$	Resolution
Digit	The number of letters of each width length in LCD	$0\sim99 \times 0\sim99$	Size of letter
Digit	The number of color type in LCD	00-99	15Gray, 256 Color, 4,096 Color, 65,536 Color, 262,200 Color, etc.

Table 2 shows PDA data comprising fields and field values. We encoded the values of the device manufacturer field with 15 mobile device makers we have studied so far. We encrypted the device model field to be able to have values from 01 to 99 by a manufacturer.

When given mobile device values and mobile model values, the values of each mobile model such as CPU, RAM, and ROM, etc. can be extracted from the server with them. In the Operating System field, the name and version of OS are encoded, in the LCD field, the number of pixels in width and height, the number of letters in width and height, and the number of colors.

Figure 3 shows the profile information related to PDA hardware characteristics such as memory usage, battery status, OS information, etc. This information would be used in providing the optimized learning on the PDA that each learner has.
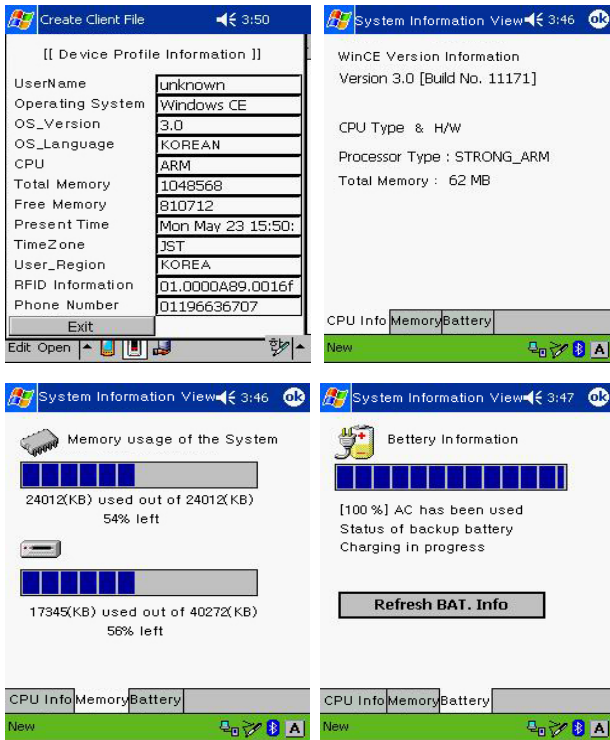

Fig. 3. Profile information collected using the profile collector

As you can see in Table 3, learner information is composed of age of learner, learning time, field of interest, learning type, and learning motive. The age of learner is encoded as a value of a fixed number and learning time is encoded as a unit of minute. Now the field of learning has its own value for a certain field related to computers, but we plan to supplement and expand the field of learning which can be supported by this system afterward. Learning type is classified into texts, motion pictures, game types, quiz types, and voice, etc. Learning motive represents the information such as Certificate acquisition, Major, Minor, and Cultural studies, etc.

Table 4 displays the organization of GPS information. The exact location of a learner and time and a date can be acquired by calculating longitude, latitude, the east longitude and the west longitude. Because formats of a RFID profile have not yet been standardized, that is a consideration later when an international standard is set.

Table 3. Learner Information Encoding

Type	Description	Set Value	Remark
Digit	Learner's Age	00~99	Age
Digit	Learning Time	00-59	Minute
Digit	Field of Learning	00-99	Operating System, Data Structure, Data Communications and Network, Software Engineering, Digital Design, Algorithm, Database, Programming Language and Compiler, etc.
Char	Learning Type	A-Z	Text, Animation, Game, Quiz, Voice, Motion, etc.
Char	Learning Motive	A-Z	Certificate acquisition, Major, Minor, Cultural studies

Table 4. GPS and RFID Information Composition

Type	Description	Set Value	Remark
String	Time	hhmmss.sss	Hour, minute, second
String	Date	DDMMYY	Day, month, year
Char	Moving direction	N	North
		S	South
Digit	Latitude	ddmm,mmmm	
Char	East/West	E	East
		W	West
Digit	Longitude	dddmm.mmmm	
Digit	RFID Information	hh.ffffff.dddddd.dddddddddd	EPC code

We encoded RFID information based on EPC (Electronic Product Code) that is currently used in popular, because RFID code structure doesn't standardize its format yet. EPC has three types of 64, 96 and 256 bit structure. It supports the existing bar code system and also has an additional part suitable for RFID. The standard EPC consists of header, EPC manager, object class, and serial number.

The RFID overall system is composed of RFID tag/reader, PDA, and RFID information database serve. We develop the RFID tag reader that has USB interface for connecting to PDA. The RFID database server provides the information corresponding to the RFID code which is read from the RFID reader.

Figure 4 shows the diagram of learner profiling and customizing system. As you can see in the figure, we devised the Learner Diagnostic Model to profile learner information considering learner level and learner attributes including preference and interest. The learner level information could be provided using diagnostic items.
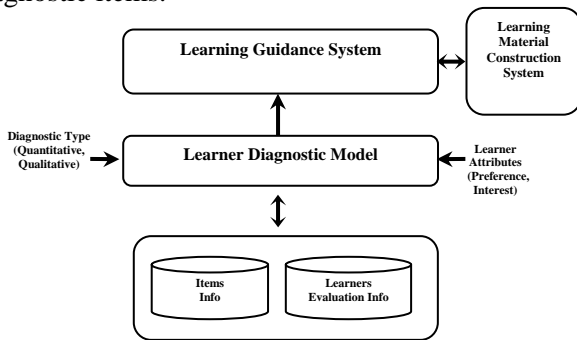

Fig. 4. Learner profiling and customizing system

Fig. 5. Learner Diagnostic System

Figure 5 represents the learner diagnostic system developed using PHP and MySQL. As you can see in the figure, there are the user interface for learner's information, the learner's diagnostic item, and the graphical result of the diagnostic. After making the learner diagnostic, the learner's detailed profile information and the static profile information are sent to the gateway through encoding on the http protocol header in order to provide a customized learning.

5 Developing a RFID System

5.1 Anti-Collision Algorithm

In RFID system, when there is a query to a tag attached to a thing, a tag identification has been made through the response process that the corresponding thing transmits its identifier to the reader. During the process of the tag identification, if there is only one tag within the effective area, the tag identification has been made easily. However, if there exist multiple tags in the area, collisions between tags would occur because they give responses to the tag reader at the same time. The collisions make the tag reader difficult in identifying each tag. To solve the problem, an anti-collision algorithm is required [9].

We applied Class 1 Generation 1, which is one of EPC standards, as an anti-collision algorithm. The algorithm of Class 1 Generation 1 uses bin slots, which identifies multiple tags by unit of 3 bits based on a binary tree.

5.2 RFID Reader

The RFID reader consists of RF and MCU (Multipoint Control Unit) and the size of the RFID reader is 49mm×82mm. It supports basically serial communication port.

5.3 RFID Middleware

In our profiling system, there is a mobile RFID middleware in order to support RFID applications. The overall framework of the mobile RFID middleware is shown in Figure 6. The Event Management Module consists of filter, queue, and logger. The filter filters out duplicate or invalid data and the queue stores data after filtering. The logger logs data in a file and also has the function of the transmission to provide information to the upper layer.
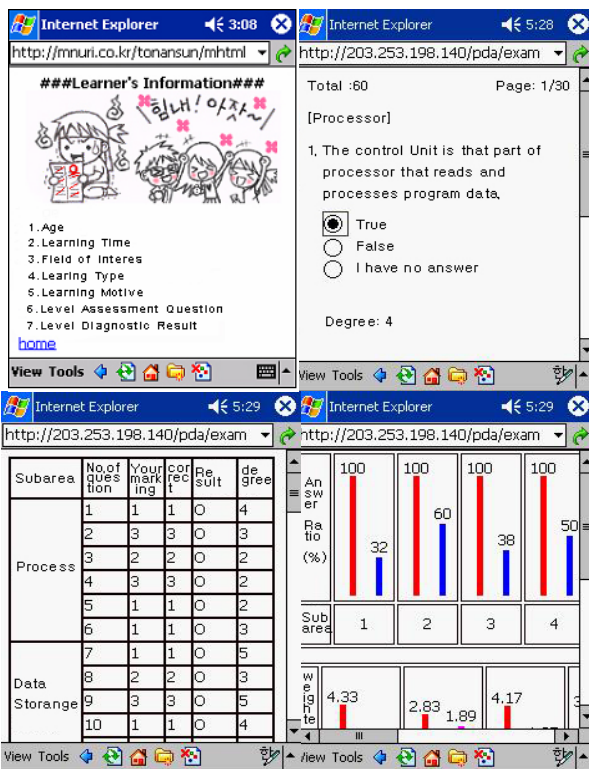
Data Management Module manages the history of tag collection.
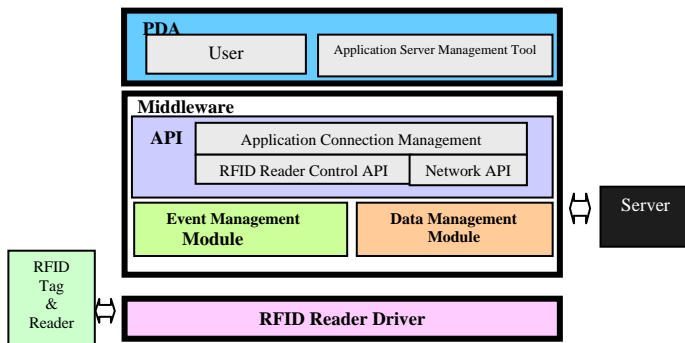

Fig. 6. Mobile RFID Framework

6 Conclusion

We proposed a mobile device profile processing system designed for customized learning. We devised a way of providing a best-suited learning environment for each learner who uses a mobile device. To do so, the proposed system extracts information about a learner such as learners' levels, learning areas, learning hours, learning preferences and so forth. In addition, it extracts information about a learning environment such as specifications on mobile devices as a learning tool, a learner's location, a distinguisher of an object in a learning environment, and so on.

Acknowledgements

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