The Approach of Device Independence for Mobile Learning System

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Abstract

Mobile learning is transforming the way of tradition education. But most of e-learning system and contents are not suitable for mobile device. In order to provide suitable mobile learning services, the approach for self-adaptation is proposed in this paper. Firstly, the formal definitions of context and its influence on learning service, including NCxt, side S, weighing Q and adaptation coefficient E, are presented. Then, using the approach, the mobile learning system is constructed. The example implies this approach can detect the contextual environment of mobile computing and adapt the mobile learning service to the mobile learners' device automatically.

Keywords: *Mobile Learning; Context; Device Independence*

1. Introduction

The rapid adoption of mobile computing devices with Internet capabilities, such as computers, smart phones and handheld devices, makes us work or study at any time, at any place. And mobile learning will complement and add value to the exiting learning models [1].

It is important for mobile learners to get education information and service, which meet their needs in an adaptive manner. Two kinds of adaptive manner should be implemented by mobile learning system, which adapt not only to mobile learners, but also to mobile devices. In this paper, the mobile learning system with the ability of device independence is discussed.

Currently, some researches about device independence in mobile learning system have been proposed. Xinyou Zhao proposed a device-independent architecture for mobile learning, which is composed of device detector and adapted content model [2][3]. That system detects the features by using user agent and analyzing the head of request. Anastasios A. Economides presented a framework for adaptive mobile learning in order to stimulate and support providing service [4]. But all before-mentioned system frameworks are not extended easily, because the formal model of context and adaption is not presented. When more and more new-style devices are used to mobile learning system, this shortage will be obviously.

In this paper, one approach is proposed to construct mobile learning system. It can detect mobile devices' context and adapt the service to the device, by considering the influence of context on service parameters.

2. Context and its influence

The mobile learning system is composed of one server and learners' devices which access the server via different types of networks, for example, GSM, 3G, internet, Wi-Fi, or other networks. The learners' devices maybe are PDA, computer, mobile phone, laptop, digital TV, or other devices which have the ability to access the network, play audio and video program, and access the system server using browser which support standard communication protocol.

The learners' devices communicate with the mobile learning system server interactively. The device sends the request of learning service to the server. Then the server provides the mobile learning service, such as video on demand, to the learners' devices. The learner's devices can communicate with others through the server.

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2.1. The context of device

Abstractly, the mobile learning system is one hub-spoke network.

Definition 1 the mobile learning system is network G=(V，E)，V is the collection of vertices, E is the collection of edges.

In the mobile learning system, one node may join and leave the network randomly. G is a time-dependent random network.G is one tree whose depth is 2. The tree G has n+1 nodes. All nodes are leaf nodes except the root node V_0. Here, V_0 is the mobile learning system server, and other nodes are learners' devices.

Definition 2 Context of the leaf nodes is NCxt(t) = { $NCxt\_item_1$ (t), $NCxt\_item_2$ (t), …… $NCxt\_item_n$ (t)}, t is the time, NCxt_item is the item of context.

Table 1. The structure of framework

< NCxt (t)>:
< $NCxt\_item_1$>
<Who>,<Where>,<When>,<What>
< $NCxt\_item_2$ >
<Who>,<Where>,<When>,<What>
……

At time t_0, $NCxt_{t0}$ = ($NCxt\_item_{1\ t0}$, $NCxt\_item_{2\ t0}$, …… $NCxt\_item_{n\ t0}$).

NCxt_item can be represented using framework. In the frame of NCxt_item, every slot is quaternion (WHO, WHERE, WHEN, WHAT). Here, WHO is the identifier of slot, WHERE is the space attribute of slot, WHEN is time attribute of

NCxt(t) is the context of node V_i and E_i which connect with V_i.slot, WHAT is the value of slot. For example, the context element $NCxt\_item_j$ = (bandwidth 1-2, Ø, 2007-3-31 10h15m30s, 20kbps), which means the identifier of context element of slot is bandwidth 1-2, and the value is 20kbps at 2007-3-31 10h15m30s. The structure of the frame of NCxt (t) is shown in table 1.

2.2. The influence of context

When providing the service, in order to adapt itself to several kinds of devices, the mobile learning system should adjust the parameters of information communication according to the context of devices. In this way, every learner can obtain the mobile learning service automatically with the quality matching the ability of his device.

Definition 3 Side S is the matrix of information transmission parameters, the number of parameter is called as the number of side s.

$S = [S_1\ S_2\ .....S_M]^T$, here M is the number of side, S_i is called as the i-th side.

For example, in order to ensure the transmission quality to all devices when providing video service, some parameters, such as speed, resolution, format and color, need to be adjusted to the context of device. They are called as side. S=[speed resolution format color]^T . And the number of side is 4.

Definition 4 Weighing Q is the degree of influence of the context NCxt on the side S.

If side S is a matrix with ($M \times 1$) elements, and NC is one matrix with ($N \times 1$) elements which are values of WHAT of all NCxt_item, the Q is one matrix with ($M \times N$) elements.

$$Q = \begin{bmatrix} q_{11}, q_{12}, ..., q_{1N} \\ q_{21}, q_{22}, ..., q_{2N} \\ ..... \\ q_{M1}, q_{M2}, ..., q_{MN} \end{bmatrix}, \quad 0 \le q_{ij} \le 1 .$$

Here, q_{ij} is the weighing coefficient of influence of the j-th NCxt_item on the i-th S.

Definition 5 Adaption Coefficient E is the integration effect of the context NCxt on the side S.

$E=[E_1\ E_2 \ldots\ldots E_M]^T$, here, E_i is the integration effect of the context NCxt of G on the side S_i.

$$E = Q \times NC .$$

When providing the mobile learning service, the mobile learning system adjusts the information transmission parameters to the context of G according to E.

There are some rules in the mobile learning system. These rules have the same structure as 'IF *conditions* THEN *adaption policy'*. While E_i match the condition, this rule will be triggered immediately, and the adaption policy will be implemented. After calculating the adaption coefficient E, the mobile learning system will adjust the parameters of the i-th side according to E_i and rules.

3. The approach

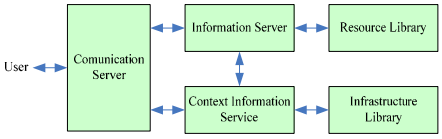

Figure 1. Modules of the mobile learning system

The mobile learning system has five modules, whose relation is shown in figure 1.

The Communication Server manages the connection with user and the quality of data transmission. The Context Information Service captures and stores the context of user's devices, builds and maintains the

relation between the device and the infrastructure which needs to be installed in the user's device. The Information Server responds the mobile learning service request from user and provides service on demand to user. When it provides mobile learning service, the Communication Server, which cooperates with the Information Server, adjusts the information transmission policy according to the context which be retrieved from Context Information service. The Resource Library maintains all the multimedia resources which are used for mobile learning service, such as audio courseware, video courseware, class service

Table 2. The Algorithm

Received the request of mobile learning service.
Build the connection between the Information Server and the learner.
Capture the context of learner's devices.
Store the context of learner's devices.
Set Q, S. E=Ø.
Scan the infrastructure library.
If there is some widgets need to be installed
Then push these widgets and install them.
Scan the context of learner's device.
NC=NCxt.what.
$E = Q \times NC$.
For i from 1 to M
Set the information transmission parameter according to E_i.
End
Start to provide the mobile learning service.

online, etc. The Infrastructure Library stores and manages the widgets for multifarious learners' devices, which need to be installed in the device, for example, audio player, video player, driver, Java VM, etc.

In order to provide the mobile learning service with the ability of device independence, the Communication Server should have the ability to capture the context of the learners' devices and adjust the information transmission policy according to the context.

The algorithm of adjusting the information transmission policy is shown in table 2.

4 Example

Learners can get the video courseware resource by VOD service provided by this mobile learning system. They can get these video resources by many kinds of device, such as PDA, mobile phone, laptop and computer. The mobile learning system must apperceive the context of terminal device, and adjust the transmission policy to the different context.

S is the sides of VOD service. S={S_1, S_2, S_3}. Here:

S_1 = transmission speed, which means how many frames the server transmit to user per second.

S_2 = size and resolution.

S_3 = color. It is colorized or black-and-white.

In this example, the bandwidth, type of link, the vender and model of terminal, the size of screen are considered as the context of device.

NCxt = ($NCxt\_item_1$, $NCxt\_item_2$, $NCxt\_item_3$, $NCxt\_item_4$, $NCxt\_item_5$), here,

$NCxt\_item_1$.who = bandwidth,

$NCxt\_item_2$.who = link_type,

$NCxt\_item_3$.who = vender_model,

$NCxt\_item_4$.who = size_screen.

$$Q = \begin{bmatrix} 0.6 & 0.4 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \end{bmatrix}.$$

NC=NCxt.what.

$E = Q \times NC$.

The contexts of mobile device are detected by the context information server, and then the adaption coefficient E is brought out by context and weight Q. In order to ensure the quality of mobile learning, some information transmission policy is carried out according E.

5 Conclusion and expectation

Mobile learning system should detect the context of learner's devices, and then adapt the service parameters to the context. In order to construct the mobile learning system, the formal definition of context and its influence on service quality is presented.

In future, the rules repository will be researched and optimized, employing the method and theory of artificial intelligence.

6. References

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