Agent-based Approach for Mobile Learning using Jade-LEAP

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Abstract. The rapid evolution of mobile and wireless technologies has created a new dimension of modern people's lifestyles; it facilitates their daily activities and summaries distances between them, and allowed them to do several tasks whenever they want and wherever they go. When these technologies started to be used in conjunction with learning a new paradigm has been emerged, it's about mobile learning. Since its emergence it has been raised a lot of attention by researchers whose attempt to propose approaches that address limitations of mobile learning environment. A promising technology which can reduce most of these limits is used in this paper which is mobile agent technology. This paper seeks to provide an agent-based approach for mobile learning systems using jade-LEAP platform.

Keywords: mobile learning, mobile agent, jade-LEAP.

1 Introduction

Mobile learning has emerged as an "anytime anywhere learning". Therefore, learning content and services must be always available and delivered to the learner whenever he wants and wherever he goes. However, mobile learning environment has a number of constraints which may hinder mobile learning applications designers to reach this potential. These constraints are related to the limitations of the mobile devices themselves which have reduced processing power, low memory capability, limited battery life and display capability. However, these limitations are reduced at present, since the exponential growth of mobile devices and adoption of the computer capabilities in those devices. Other limitations are related to the wireless networks which have high latency and transmission delays, and low bandwidth especially with considerable number of users, as a result the size of data exchanged should be optimized. Moreover, wireless link may not be available in permanent way, in addition to the expensive and fragile network connections which creates problems for services designed to operate with fast and reliable and continuously open connection.
The other side, mobile agents are a promising solution that can reduce problems

mentioned above; furthermore they facilitate introducing automatic and dynamically adaptive learning methods. Thus, we propose an agent based approach for an effective mobile learning systems using jade-LEAP platform. The remainder of this paper is organized as follows. First, we present an overview of jade-LEAP platform. Second, we describe in detail our proposal. Finally, our conclusion and future work is given.

2 Jade-LEAP in mobile devices

JADE-LEAP (Lightweight and Extensible Agent Platform) is an extension of JADE platform that can be deployed not only on PCs and servers, but also on lightweight resource devices such as Java enabled mobile phones. In order to achieve this, JADE-LEAP can be shaped in different ways corresponding to the two configurations of the Java Micro Edition and the Android Dalvik Java Virtual Machine: [1]

- **Pjava:** to execute JADE-LEAP on handheld devices supporting J2ME CDC or PersonalJava such as PDAs.
- **Midp:** to execute JADE-LEAP on handheld devices supporting MIDP1.0 (or later) only, such as the Java enabled cell phones.
- **Android:** to execute JADE-LEAP on devices supporting Android 2.1 (or later).
- **Dotnet:** to execute JADE-LEAP on PC and servers in the fixed network running Microsoft .NET Framework version 1.1 or later.

These versions provide the same APIs to developers thus offering a homogeneous layer over a diversity of devices and types of network, except the midp's version which have some unsupported features compared with the other versions of jade-LEAP. [1] Jade-LEAP provides two execution modes to adapt to the device's

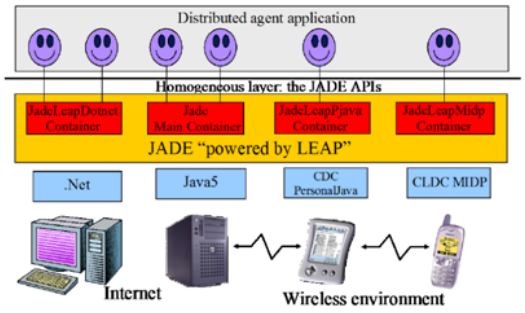

Fig. 1. The JADE-LEAP runtime environment [1]

constraints; the normal "Stand-alone" execution mode suggested in .net environment and supported in Pjava and Android. In this execution mode a complete

container is executed on the device/host where the JADE runtime is activated. The "Split" execution mode is mandatory in Midp and strongly suggested in Pjava. In this execution mode the container is split into a FrontEnd (actually running on the device/host where the JADE runtime is activated) and a Back-End (running on a remote server) linked together by means of a permanent connection.
This execution mode is very useful for our work because it use less memory and need less processing power on the mobile device, since the Front-End is definitely more lightweight than a complete container. Furthermore, it allows us to let the intensive processing tasks to the remote server and let the mobile device. It has the advantage of minimizing the bandwidth and optimizes wireless connection to the main container, since all communications with the Main container required to join the platform are performer by the Back End and therefore they are not carried out over the wireless link. Thus, the bootstrap phase is much faster.
In our work we attempt to implement the Jade-LEAP in mobile learning environment and benefit with the advantages of the split execution mode mentioned above, which addresses some limits of the mobile learning environment such as: low bandwidth.
There are several multi-agent platforms for mobile devices such as The MobiAgent [2], AgentLight [3], MicroFIPA-OS Agent Platform [4], and jade-LEAP [1]. We choose the jade-LEAP platform for many reasons such as: [5]

- Extension to JADE which written in java, and have features such as the possibility of executing multiple concurrent tasks (behaviours) in a single Java thread, matched well the constraints imposed by devices with limited resources. [1]
- Supports large variety of devices such as Java MIDP-capable phones, PDA devices,
- Smallest available platform in terms of footprint size,
- Proprietary device-initiated and socket based communication channel with main container,
- Developed within LEAP project,
- Open-source.

3 The proposed Architecture

We are proposing a multi-agent architecture for implementing mobile learning system which supports context-awareness and adaptive learning content using jade-LEAP platform. In our proposal we used agents to benefit of their advantages such as autonomous, reactive, proactive and social. The other side, we need to reduce wireless network problem by the use of mobile agents through the wireless connections to the mobile devices. The detailed description of these agents is articulated below:

1. **Interface Agent:** it is a stationary agent which have several tasks:

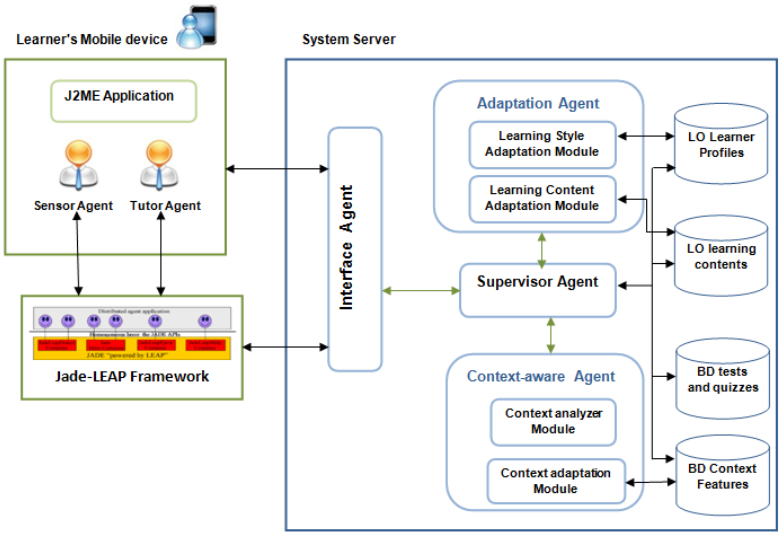

Fig. 2. Proposed Architecture

- It performs the authentication of the new learner, and checks user authorization by verifying the password.
- It acts as a communication point between learners' devices and the system.
- Send requests to Jade-LEAP platform to create and send mobile agents to the learner device.
- It informs the Supervisor Agent to update or store information concerning the learner profile.

2. **Sensor Agent:** we called it sensor because it sense the learning environment and react accordingly to changes. This mobile agent has a role of monitoring and tracking the learner in his learning process and save his behavior and relevant data about it.
   - Send information about the device's features (memory size, processing power, available connectivity, communication costs, bandwidth, and battery level) to be saved in the context device features database.
   - Send observation about the learner; the duration of learning a course, concentration level (how often he interrupted by an external event such as a call or a message, navigation behavior, etc), how often he check the help page, duration between two connection to the system, and then send a report to the system when the student is disconnected.
   - Save the current learner location and send a request to the system contains the current learner location when the learner changes it to update context data base and to adapt course content to the user location.
3. **Tutor Agent:** A mobile agent that manages the course delivery to the remote learner. The main tasks of the tutor agent are:

- Carry and manage the adaptive course material based on the learning style of the student.
- It saves the pause point of the learner when he logout, and start from this point when learner login.
- It insures the display of services and learning content according to the user preferences and device capabilities, in collaboration with the sensor agent.
- Bring the test content to the learner and retrieve his answers to the adaptation module which calculate and send him his note.

4. **Context-aware Agent:** Context-aware Adaptation Agent consists of Context analyzer module and context adaptation module. Context analyzer module charges of analyze the information sent by the sensor agent and filter it to extract data related to the context, it receives periodically data from sensor agent, then it models this data and classify it according to its priority to be treated effectively by the context adaptation module, it send user profile information and context information to the supervisor agent who associates it to the context features and to the learner profile.
   Context adaptation module use the information retrieved by context analyzer module and apply it. For example, if the user has a limited bandwidth connection, then we must reduce multimedia content, and in the worse case we can replace it with text. On the basis of the present context, context adaptation agent predicts the future context and performs appropriate activity. For the previous example, it will transmit only data with small size.
   Finally, context adaptation module transmits context into adaptation module via the supervisor agent, which in turn save the learning context and incorporates it with adaptable learning content.
5. **Supervisor Agent:** It is a supervisor agent which has the role of monitoring the functionality of the system. It considered as a mediator between the system modules and it coordinate between them. It is the only agent who has the ability to change and update data in the learning object repositories (context features, learner profiles), with the help of interface agent which request it to create a new learner profile and informs it about data changed in the learner context.
6. **Adaptation Agent:** Since learners have different learning styles and devices have different characteristics, it has been necessary of personalized learning content. This task is realized by the adaptation agent, which consists of two modules; learning styles adaptation module and learning content adaptation module. These two modules coordinate between them, that is, learning style adaptation module matches the appropriate learning objects according to the learner style to be chosen later by the learning content adaptation module who manages the knowledge about courses and teaching strategies, and packaging the course material and tests according to the user profile and device profile.
7. **J2ME Application:** The Java 2 Micro Edition was, at the time, quickly becoming a de facto standard to develop mobile client-based applications [1]. This is application is deployed and runs in learner's mobile device such as

java-enabled mobile phone, PDA, Smart phones, etc. after the learner download the jar file, he could install the application on his device. It displays a usable and appropriate interface which suit to the screen display capabilities. Via this interface user access to the learning material, and benefit to services offered by the system. So it act as a mediator between leaner and mobile learning system.

4 Conclusion and future work

In this paper we have described our proposed context-aware and adaptive learning system for Mobile Learning using mobile agent technology, which considered as promising solution in mobile learning systems, it may facilitate introducing automatic and dynamically adaptive learning for effective mobile learning systems. We are currently designing the system prototype which will be implemented using JADE-LEAP platform.

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