Context-aware Adaptive Delivery Mechanism and System Architecture

Kalla Madhusudhana

Abstract— Adaptive delivery mechanism is useful to provide learning resources based on individual contextual differences. The goal of such adaptive environments is to make learning material deliverable as per the device, domain and activity of learner. To tackle these problems this research paper discusses content delivery mechanism and proposes architecture of the context-aware adaptive delivery process. The proposed architecture differs from other architectures in using the Ontology for modeling of learner context and resource description. We describe the use of associated ontologies, and working process of context-aware system architecture.

Index Terms— System Architecture, Ontology, Context, Adaptive Delivery, Resource Description

1 Introduction

THE learning content adaptation environment needs to provide an accessible relationship between the learner and the learning resources as per the context of learning environment. Through modeling learner context and context aware description of resources makes content delivery as per the accessibility constraints of e-learner.

Most of the Learning environments do not take into account individual aspects of learners. Adaptive e-learning systems carry out adaptation in accordance with a user model and they are offering personalized solutions to suit individual learners' needs [1].

As the Semantic Web technologies emerge, we believe that new research opportunities for building ontology based context-aware adaptive systems. The use of ontology is a key requirement for realizing context-aware adaptive systems [2]. Adaptive e-learning systems can be defined as systems offering personalized solutions to suit individual learners' needs [3]. To provide personalized solutions it is necessary to investigate the learner profile, domain, Preferences and activities.

The context ontology must provide means to express knowledge about the learner's context in which learning activity is performed. The resources ontology is a description that allows the searching and retrieval, based on standardized meta-data. The ontologies and rules provide an excellent platform for building a highly-responsive context-aware interactive application [4].

We present in this paper an approach to eLearning adaptation based on context ontology by considering the learner side aspects such as domain, activity, device and user approach as basic contextual elements. We described a new architecture that exploits Semantic Web technologies for supporting context-aware e-learning system.

- *Dr. KALLA MADHUSUDHANA, working as Professor in Department of Computer Science and Engineering, Of CVR College of Engineering, Hyderabad, Telangana State, India.*

kallamadhu1@yahoo.com

2 Related work

In the past, a number of system architectures have been developed to support context aware computing. The literature review present in this section is concerned to recent adaptive and personalized e-learning applications based on learner context. The semantic Web technologies especially ontology seems to be an efficient modeling approach and can be used to take adaptation decisions [1].

Nguyen, [5] proposed personalized context – aware mobile learning architecture for supporting student to learn English as foreign language, It adapts learning materials according to the learner's knowledge as well as their location, their available time.

To learn an object-oriented programming language such as Java, Yau J [6] described the system prototype architecture for Context-aware and Adaptive Learning Schedule (CALS) tool the tool is able to determine the contextual features such as the location and available time of learner.

The adaptive educational hypermedia systems (AEHS) to adaptively select and sequence learning resources addressed by Karampiperis [7], the design problem of the Adaptation Model in AEHS proposing an alternative sequencing method that instead of generating the learning path by populating a concept sequence with available learning resources based on adaptation rules, it first generates all possible sequences that match the learning goal in hand and then adaptively selects the desired sequence, based on the use of a decision model.

Yau JY & Joy M. A, [8] Proposed Mobile Context-aware and Adaptive Learning Schedule (mCALS) tool, that provide opportunity to students to learn in different locations and facilitate time management. This approach facilitates context-awareness mobile learning field. It is mainly intended to aid self-regulated learners on object-oriented programming language such as Java.

The Units of Learning mobile Player (UoLmP), developed by Gómez, Sergio, et al [9], aiming to provide a "General adaptation" for mobile learning, so as to support learners by delivering adapted activities and materials through every step in the learning flow of a mobile educational scenario. UoLmP's

architecture focused on generating adapted individual learning activities, as well as offering adaptations to supportive educational resources, tools and services, based on processing different criteria derived from learners' contextual elements.

3 Adaptive Delivery Mechanism

The Content Delivery Mechanism selects learning resources and deliver to the user by using query statements that may correspond to SQL statements or SPRAQL statements (if contents are managed using Ontology). As shown in Figure 1 the adaptation logic which is derived from learner-context model is used to perform adaptive delivery of learning contents as per the learner context.
Here is an example scenario:

If student "X" doing "Computer Science" course selects material in the video format of "Graphics" subject, then the context can be as follows:

Context of Student X=
{
(Student . X , isCoursing , Course . Computer Science)
(Course . Computer Science , hasTopic , Topic . Graphics)
(Student . X , hasDevice , Device . PC)
(Student.X , hasPreference , Preference)
(Preference , ofMediaType , Media-Type .Video)
}

For example the SWRL adaptation rules based on Domain Specific Learner Context can be considered as follows.

(Student (?St) ⋀ isCoursing (?St, ?Ct) ⋀ Course (?Ct))
(Course (?Ct) ⋀ hasTopic (?Ct, Tp) ⋀ Topic (?Tp))
(Preference (?Pr) ⋀ ofLearningOrientation (?Pr, Lo) ⋀ LearningOrientation (?Lo))

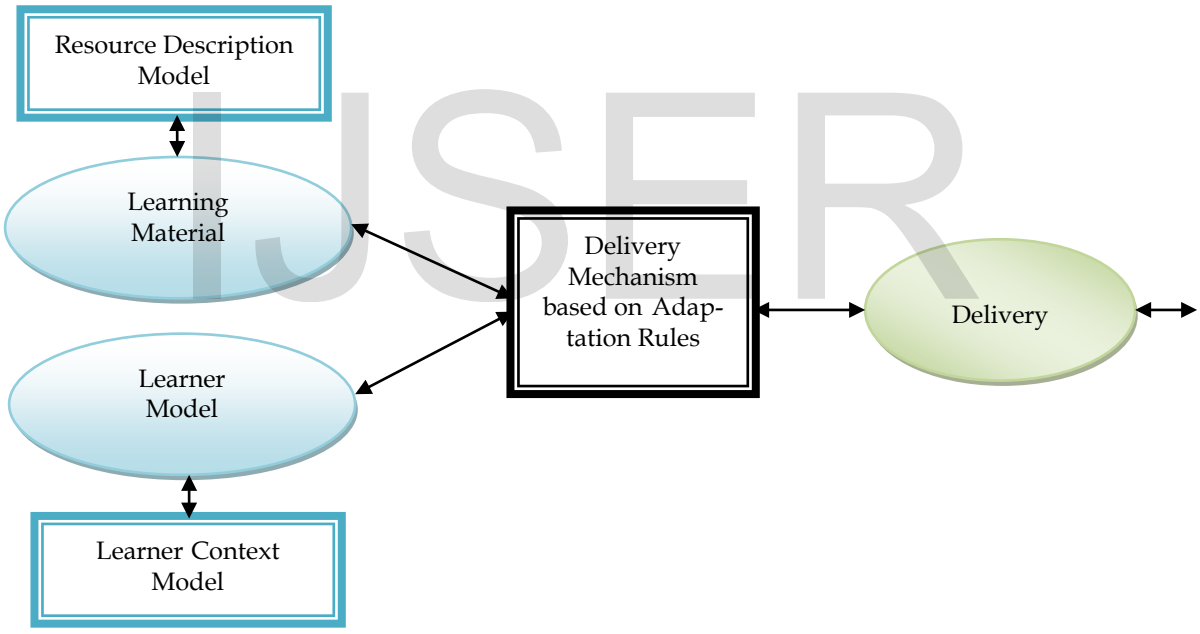

Fig 1 Content Delivery Mechanism

4 Resource Description Model

When learning materials are stored in a database, without external description other than the database itself, it can be difficult to decide what a learning material is supposed to mean and for what requirements or context of learner it can be delivered. So the learning material must be accompanied with concerned content description ontology [10].

The ontology based resource description modeling and presentation of course contents facilitates the learner to understand everything related to particular learning concept. The ontological representation of various topics of course can be formally denoted as G (T, P, R), where

T = Set of topics of specific course or subject

P = Property set such as ID, Name, Description, etc.

R = Relation set indicating the semantic relationships between the pair of concept

5 Learner Context Model

These learning materials are accessed by learners which differ in a wide range of characteristics, requirements and preferences.

Device: A number of context-aware learning tools have been proposed by different authors by considering various hardware and software parameters of learning device. Here, we include only the communication Network bandwidth, Software, and Hardware details of learning environment.

Activity: To determine the set of activities for a learning process in online learning environments, the live web actions are acquired from the student's access log. The access log indicates the learner's emotional state, focus of attention and background knowledge on learning domain. Thus the system also has the option to interrupt the user and to recommend appropriate material.

Domain specific: The context that supports to enrich the knowledge or understanding level of learner can be considered as domain specific. We believe that learner context concerned to Domain is mainly concerned to subjective and technical, and Application supportive of concerned domain.

Preferences: The learner preference profile provides the information related to the learner's learning topic such as Interest, goals, language, etc. The user preference attributes include user's knowledge level for that topic [11] and learning style.

Figure 2 shows the user-context categories and their elements. The categorization is used to identify to which extent the context aware adaptive system is able to deliver learning resources to user.

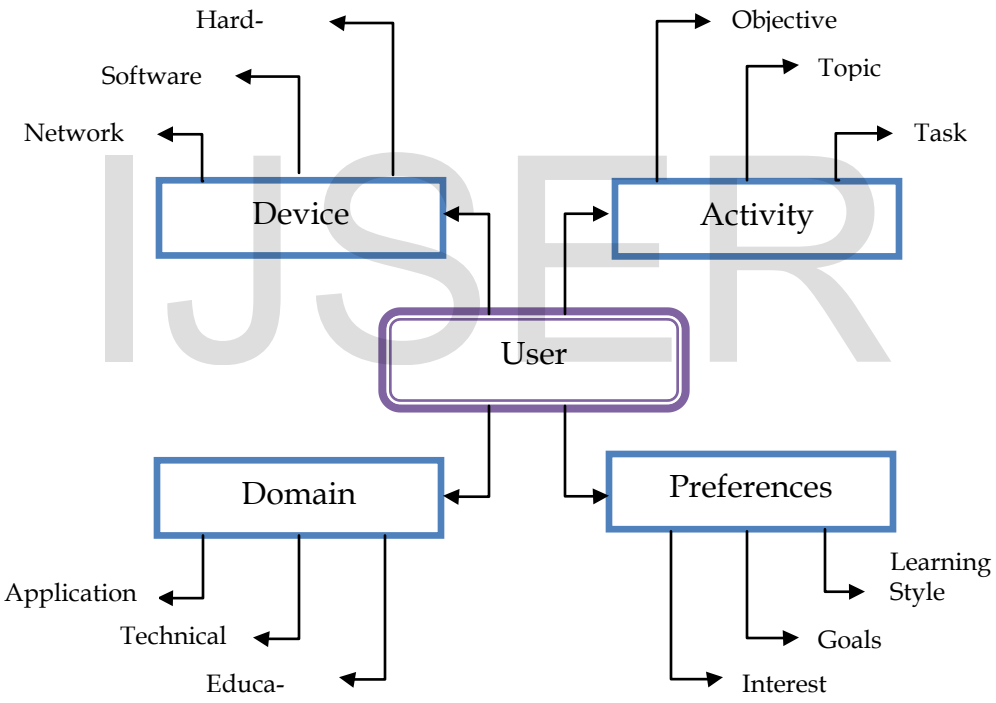

Fig 2 User-context Categories and their Elements

6 System Architecture

In this section we focus on context-aware system architecture in which the learner context model and description of course contents using an ontological approach are the integral parts of the system. The concerned system architecture is as illustrated in Figure 3. The goal of the system is to deliver appropriate learning resources for students based on their current context and preferences.

6.1 Working Process:

Learner carries out the learning activity by interacting with the application through the input query on the learner's device interface. The learner will be asked to complete inputting of personal information to conform learner's identity if the learner is registered. The HTTP request is evaluated to confirm the identity of learner.

The system observes the learning device type by means of device detection module and the learner preferences by means of

user profile database. The device centric and learner centric contextual information is stored under context-id of relevant learner-id.

The adaptive rules in Semantic Web Rule Language (SWRL) format are responsible for adaptation. The adaptive SWRL rules are developed based on ontology based learner context model.

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}

Based on learner contextual information the adaptation process selects learning resources using query statements that are corresponding to SPRAQL (Simple Protocol and RDF Query Language) statements. The behavior of the context aware adaptive delivery process consists of the following steps and is depicted in Figure 4.

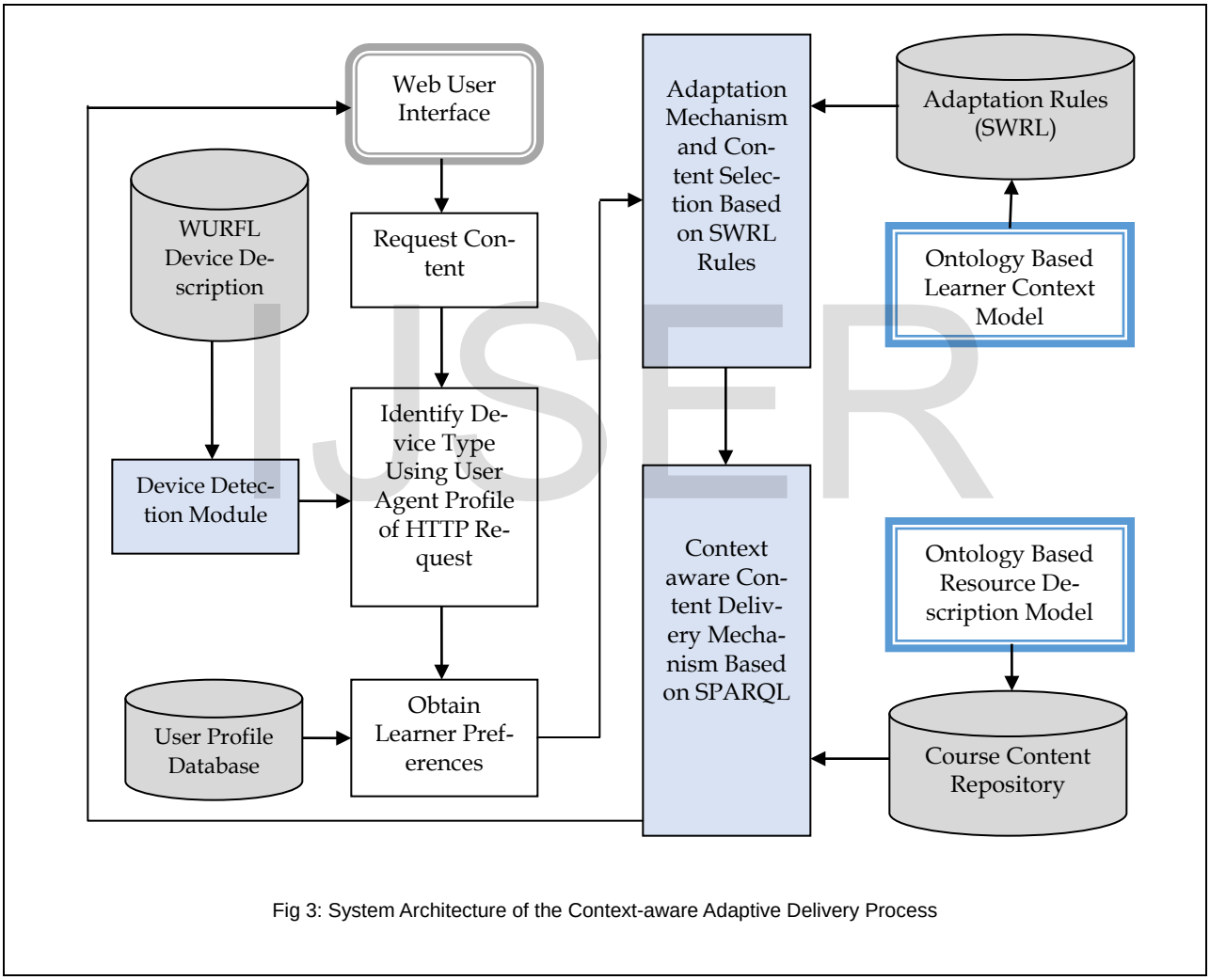

Fig 3: System Architecture of the Context-aware Adaptive Delivery Process

7 Conclusion and Future Work

In this paper, we have introduced our novel Context-aware and Adaptive Learning System Architecture which could aid user-centric adaptive learning system. This study also discussed the use of associated ontologies for resource description and learner context modeling. We are currently designing and developing the system prototype which will be implemented and evaluated.

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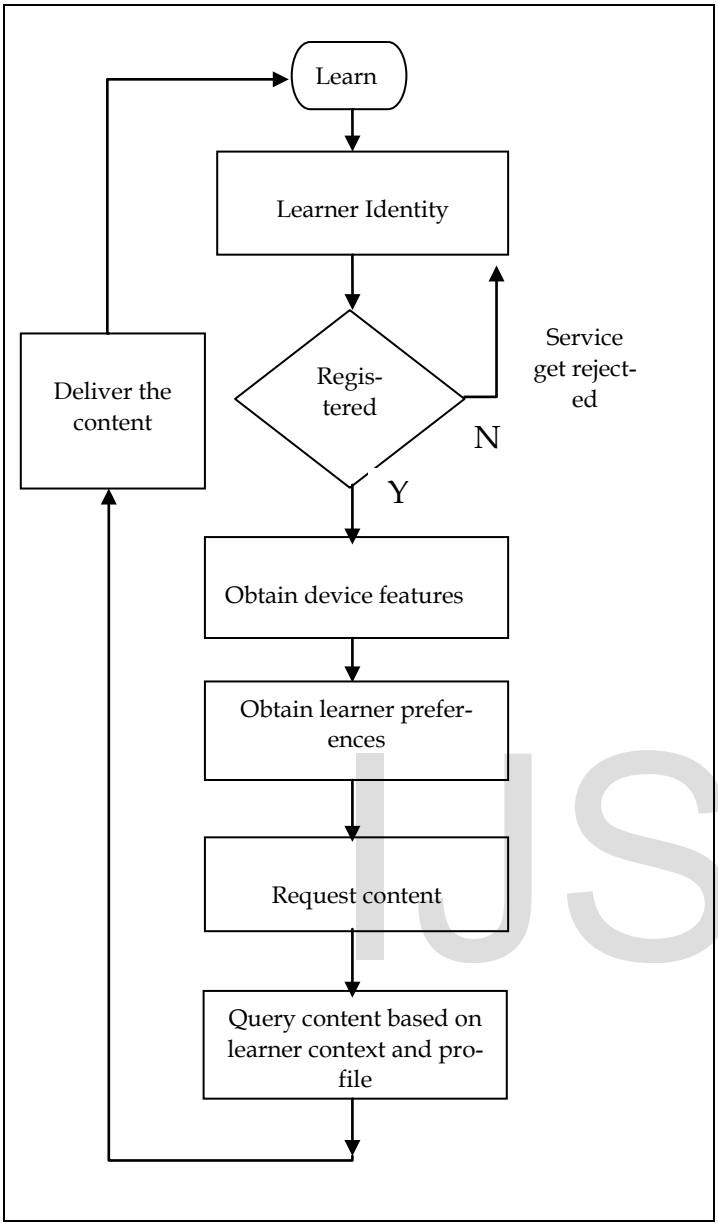

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