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A Model Driven Framework to provide Accessible E-learning for Students with disabilities

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Abstract

This paper exposes an approach to create accessible contents for e-learning objectives dedicated to handicapped persons. This preliminary study focuses on the proposition of a generic abstract meta-model that can be used to define specific models for different platforms and user configurations.

1. Introduction

Nowadays, e-learning benefits from the fastest growing of Technologies of Information and Communication to empower education and create very sophisticated environments. However, little attention has been devoted to making these technologies accessible to people with various disabilities. In this context, we are working to create a barrier-free learning environment for students with disabilities.

Our project consists in studying the field of accessible e-learning in order to give handicapped users the opportunity to access education using Internet and new technologies just like any other students. This work is based on the OMG's Model Driven Approach [11].

2. State of the art

2.1 Accessibility

The scientific community has recently been aware about the importance of accessibility of disabled people to information technologies, called numeric accessibility. This word is specifically used to describe tools and means allowing users regardless of their culture, language, age, disability to reach information and new technologies like Internet, without dependence or aid.

In this context it would be desirable that a handicapped person reaches e-learning in the same way and in the same conditions that another person. The W3C Web Accessibility Initiative (WAI) has been established to raise awareness of universal access. WAI develops guidelines which can help to ensure that Web pages are widely accessible.

The WAI gives a set of recommendations including: the *Web Content Authoring Guidelines* WCAG [2], the *Authoring Tool Accessibility Guidelines* ATAG [10] and the *User Agent Accessibility Guidelines* [7]. The WCAG is intended for web authors, while the ATAG and UAAG are intended for software development communities. Furthermore, since Internet is the first vehicle of e-learning resources, we can consider that the WAI guidelines may be applied to e-learning objectives.

The recommendations are valuable but their main problem is that they are aimed to be universal while learners are different and have specific needs. In addition, they are sometimes complex to apply. The challenge for researchers and developers is to develop tools that help the application of the WAI guidelines in the e-learning field.

2.2 Assistive technology

Assistive technology is any mean: hardware or software, used to increase, improve or maintain capabilities of disabled persons. It makes handicapped people able to execute tasks that are sometimes difficult or impossible to do without technical aid, and helps them achieve their scholar, professional and social integration.
Assistive technology includes many categories. We are mainly interested by assistive technology aimed to facilitate the use of a computer by a handicapped person. This technology can be composed by conception, methodologies, input/output devices, and specific or adapted software that facilitate access to a computer.

The present tendency in conception methods is to achieve what is called universal access through the application of “design for all "or" universal design ". The universal conception encourages the computer system development that is flexible enough to meet needs of the larger range of computers users, independently of age or handicap.
Input devices like Braille terminals and sensory keyboards are used by visually impaired users; alternative pointing systems used by motor disabled people (based on pressure, breath, eye movement, etc); adapted keyboards, tactile screens, etc.

Speech synthesis, speech recognition, screen enlargers, accessibility features offered by constructors such as the accessibility program of Microsoft.

2.3 E-Learning

Content Management System (CMS) platforms have become popular among web site hosts. Following this trend, Learning Management System (LMS) are being more and more used to construct distant learning environments. CMS is a system used to organize and facilitate content creation. LMS is software system designed to facilitate tasks as well as student participation in e-learning courses.

In the field of e-learning for handicapped learner, these two fundamentals systems are insufficient. To ensure the access of this category of learner to e-learning contents, we propose to add a two others systems called Accessible Learning Content System (ALCS) and Accessible Learning Management System (ALMS).

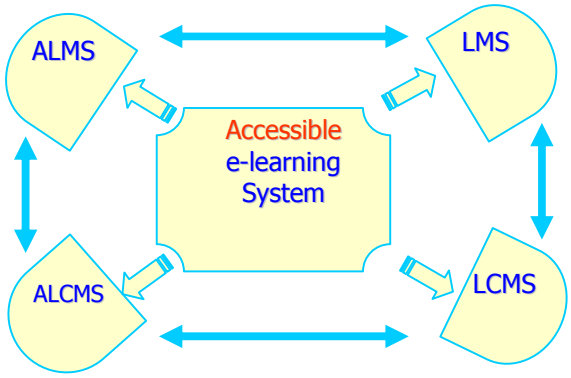

Figure. 1: Architecture of Accessible E-learning System

The object of these two systems is to add advanced personalization to classical e-learning system.
Tight integration of the ALMS and ALCMS can enable several advanced personalization capabilities that are not achieved through either systems (LMS and LCMS). In the same time it’s very important to empower collaboration and knowledge-exchange between the four systems [8]. Lack of smooth integration between these systems results in a broken solution with content and management conflicts.

3. The Proposed Model Driven Framework

MDA is an approach for application specification and interoperability which is based on the separation of concerns between domain knowledge and platform specificities. It relies on the use of MOF (Meta Object Facility) meta-models and UML (Unified Modelling Language) models for every step of the application life cycle.
This approach depends on the definition of:

- a specification model called Computational Independent Model or CIM,
- a conception model called Platform Independent Model or PIM,
- an implementation model called Platform Specific Model or PSM,
- a set of model transformations (also called mappings).

3.1 The MDA architecture

3.1.1 The CIM

The Computation Independent Model is the business model that describes the requirements of the application. UML use cases may be used at this level.

Added to basics actors in classical e-learning systems, we propose a new actor called *Assistant*. These one will ensure automatic adaptation of handicapped learner access to subscription, contents and results

3.1.2 The PIM

The Platform Independent Model is the domain concept model. It's a model that describes all knowledge related to application domain. The application components are specified without considering implementation techniques, but providing generic computing architecture. The PIM is generated from the CIM. The OMG encourages the use of UML at this level.

3.1.3 The PSM

The Platform Specific Model is the data and processing model. It describes how a PIM is adapted to an existing platform, by integrating the implementation technical details, and provides the description of a deployable software system. Starting from a PIM, we can obtain one or more PSM's for different chosen platforms. A PSM is in part generated from a PIM. At this level it is possible to use the UML profiles to construct specific cartridges for disabled learner. These cartridges represents a templates code generation with automates migration from one model to another.

Many Computer Aided Software Engineering tools support the use of cartridges and each one has a specific cartridges repository like EJB. The most important advantages of these templates are the possibility to extend, reuse and define new cartridges.

3.2 Model transformations

Model transformations are the heart of MDA, because they are the means allowing gaining in productivity. Transformation rules ensure the passage from one model to another. The mappings can be considered as applications and are described by models.

The OMG encourages the use of the standard QVT (Query, View, and Transformation) which defines the meta-model for model mappings.

4. The proposed Model

The principal idea of this work is to propose a generic framework that describes all the issues involved in creating accessible e–learning content. The generic framework defines high-level requirements in a PIM, which may be instantiated once or more to respond to different accessibility objectives (Fig. 1). The following points describe some of the multiple features that have to be considered.

The user factors The design of applications must be user-centred. In accessible e-learning field, we are in presence of different aspects of user, for example the tutor, the author, the handicapped student and the classical student.

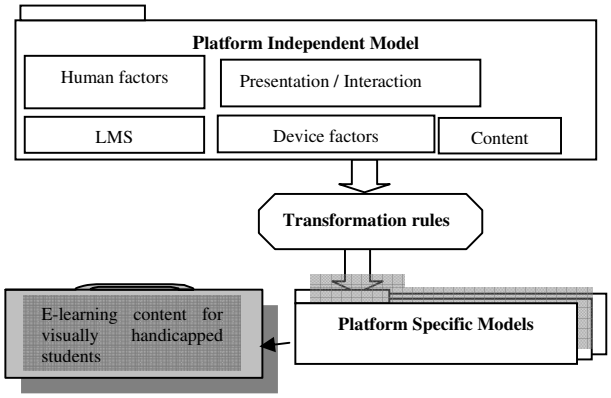

Figure. 2. An instance of the MDA accessible e-learning framework

The physical features

This part of the model describes all categories of assistive input/output devices that may be used by handicapped persons to access the web based content.

The interaction / presentation features

This part integrates knowledge about all possible forms of presentation and interaction with information. This model will have to integrate different modalities depending on the use of specific or standard devices. For example, in the case of visual impairment, the speech modality is an output format.

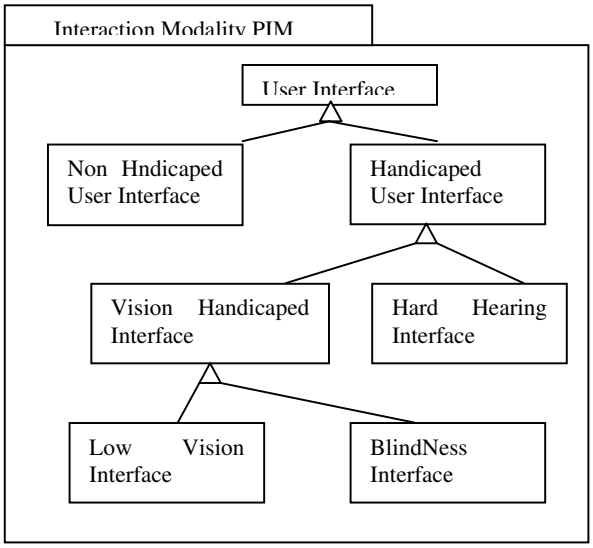

Figure. 3. Modality Interaction PIM

The pedagogic content features

The content is described in a model specifying its structure. For example, a course may be considered as a set of interrelated learning objects. A learning object can be a module, chapter, exercise, evaluation, demonstration, etc. Standards exist that permit to describe a learning content in order to make it reusable (LOM[7], SCORM[1], AICC[9], etc.).

Accessibility metadata may be added to these standards to make them respect the requirements of handicapped learners. We have to base our works on accessible content models inspired from the existing works of standardisation [5]. Furthermore, some of the WCAG recommendations may be included among these features.

The system functionality features Traditional e-learning environment, called Learning Management System (LMS) offers to the learner a set of tools that assist him during his learning process. It lets him navigate freely in the course structure, download and print documents, communicate with his colleagues and tutors with asynchronous tools as e-mail and forums and/or synchronous tools as chat and videoconference.

Learner can learn accordingly to his appropriate rate of comprehension and perform pedagogical activities and interactive auto-evaluation exercises. These features have to be adapted in order to be used by a handicapped student. Some of the UAAG recommendations and the guidelines for developing accessible learning applications [5] have to be integrated to these features.

5. Instantiation example

Let us suppose the necessity of creating an e-learning platform for visually disabled people, in particular blind students. As shown in Figure 3 we use the general framework PIM composed by the common settings for all accessible e-learning platforms. For instance this PIM contains the classical student model, the LMS features, and the pedagogic content not dependent of any accessibility.

In addition we use the blindness PIM containing models of all the features for e-learning platform and content to be used by blind people. For example:

- The device model specifies the peripherals available for blind users: Braille terminal for text editing and text typing, voice recognition for commands, and speech synthesis for navigation. All the proposed models relative to these devices are associated to our generic framework.

- The interaction/presentation model: the definition of presentation/interaction principles used with available devices for blind users.

- The user model relative to blind users.

- The pedagogic content model: like the extension of the LOM model with Meta data describing alternative presentation possibilities for the content. For example a video is tagged with metadata containing the alternative description of the video content.

The association of the two PIM's: the General framework PIM and the Blindness PIM give us a new e-learning PIM specific to blind users. From this PIM we have to create the transformation model to generate a PSM relative to the devices that will be used, for instance Braille modality, speech modality or multimodality. After that, source code is derived from the resulting PSM.

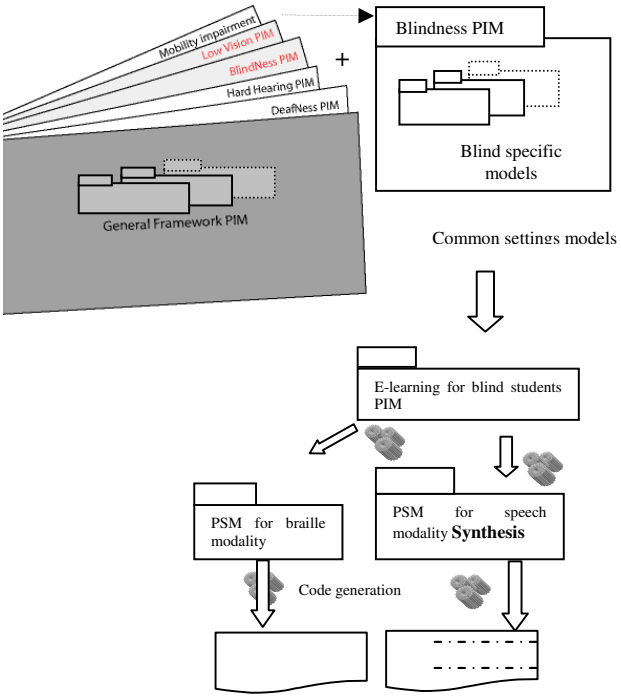

Figure. 4: Instance for blind students

The last step is code generation. To illustrate this, there are many example of possible mapping of some high-level perceptual concepts into primitives available on textual platforms such as XHTML or WML, and text to speech platforms such as JavaSpeech, Microsoft Speech API and Voice XML [3].

To adopt MDA many compute aided software engineering was created. The most important one are AndroMDA, Acceleo, Objecteering, ATL, ModFact, Pragmatic, Mia-Transformation, and Mia-Generation.
Some of which are pure code generation tools, others more full fletched model-driven tools [12].

It is always possible to enrich open source tools, like AndroMDA which is considered as one of the most powerful Open Source MDA Generators [13], by adding new customised cartridges. For example, according to PSM for speech modality listed in fig 4, we can establish a cartridge to fit blindness needs by VXML code generation like the following extract.

```
<? xml version="1.0" encoding="UTF-8"?>
<vxml version="2.0"
xmlns="http://www.w3.org/2001/vxml"

xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance"

xsi:schemaLocation="http://www.w3.org/2001/vxml
    http://www.w3.org/TR/voicexml20/vxml.xsd">

 <meta name="welcome.vxml" content=""/>
 <meta name="Author" content="HP"/>
 <meta name="Date" content="September, 2005"/>
 <meta name="Description"
     content="This VoiceXML example is provided
          as part of an HP OpenCall Media Platform
          VoiceXML installation"/>
 <meta name="Support" content="none"/>

 <form>
  <block>
   <!-- Play a message using an audio file -->
   <audio src="welcome.wav"/>
   <!-- Disconnect the call and exit the session -->
   <disconnect/>
  </block>
 </form>
</vxml>
```

6. Conclusion

The objective of our work is to increase accessibility to e-learning for disabled persons. Our approach is based mainly on the use of MDA. The advantages of the proposed MDA framework are the permanence of the specification models, the possibility to reuse existing models [6], automation of models transformations, and the originality of our work consist in using only the needed parts of a generic framework to generate specific content for a specific disability category and/or specific platforms / devices.

7. References

[1] Advanced Distributed Learning (ADL). The SCORM 2004 2nd edition Overview, Modèle de référence SCORM., <http://www.adlnet.org/downloads/207.cfm>

[2] Authoring Tool Accessibility Guidelines 1.0, W3C, February 2000, <http://www.w3.org/TR/ATAG10/>

[3] Bran Selic, Welijko Obrenovic, Dusan Starcevic. A model driven approach to content repurposing.

[4] Hodgins, W. & Duval, E. (Eds.): IEEE LTSC Learning Object Meta-data LOM_1484_12_1_v1_Final_Draft, http://ltsc.ieee.org/doc/wg12/LOM_1484_12_1_v1_Final_Draft.pdf>, (2002).

[5] *IMS Guidelines for Developing Accessible Learning Applications, SALT Project, http://www.imsglobal.org/accessibility/accessiblevers/index.html.>*

[6] Moreno N., Romero R. J., *e-MDA Framework: Model reuse in building e-learning systems*, IADAT -e2005, International conference on Education, Biarritz, France , July 2005.

[7] Needham, MA, OMG Model Driven Architecture resource page.: Object Management Group. Internet: <http://www.omg.org/mda/index.htm.> 2003.

[8] Raghawan Rengarajan. LCMS and LMS: Taking advantage of tight integration, August 2001

[9] The Aircraft Industry CBT Committee, http://www.aicc.org/

[10] User Agent Accessibility Guidelines 1.0, W3C, February 2002, <http://www.w3.org/TR/UAAG10/>

[11] Web Content Accessibility Guidelines 1.0, W3C, May 1999, <http://www.w3.org/TR/WAI-WEBCONTENT/>

[12] http://www.modelbased.net/mda_tools.html

[13] http://www.andromda.org/