Generating Multimedia Components for M-Learning

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The paper proposes a solution to generate template based multimedia components for instruction and learning available both for computer based applications and for mobile devices. The field of research is situated at the intersection of computer science, mobile tools and e-learning and is generically named mobile learning or M-learning. The research goal is to provide access to computer based training resources from any location and to adapt the training content to the specific features of mobile devices, communication environment, users' preferences and users' knowledge. To become important tools in education field, the technical solutions proposed will follow to use the potential of mobile devices.
Keywords: *M-learning, mobile devices, MPEG-21 standard, multimedia databases*

1. Introduction

The mobile learning or *M-learning* occurs when the student is not in a fixed location or when the student benefits from the opportunity of the mobile technologies [1].

The technical advantages of the existing mobile devices and technologies that advice them for usage in the instruction process are: the great number of the users of mobile devices; mobile devices have improved multimedia characteristics; the mobile devices are connect almost anytime to the communication network with great availability. The revolution in mobile devices field removes the time and place barriers and allows the instruction in any place and anytime. There are some technical difficulties because of the great variety of mobile devices available, because of the possibility to personalize these devices and because of the diversity of educational goals of the users.

The goal of the proposed solution is to create a system able to dynamically generate the educational content presented to each user, function on the mobile devices characteristics and function on users' preferences. The main advantages of the proposed solution are: the decreasing of time-needed for instruction, the decreasing of costs with instruction and the growing of efficiency.

2. Mobile Technologies Available For M-Learning

We can classify as mobile many different kinds of technology. From this point of view, mobile means portable and movable.

2.1 Mobile Technologies Classification

We can classify the range of mobile technologies using the two orthogonal dimensions of personal versus shared and portable versus static, as outlined in figure 1 [4] [11]. The first quadrant shows devices that can be classified as portable and personal. These kinds of devices are mobile phones, PDAs, tablet PCs and laptops. We can perceive these devices as being personal because they normally support a single user. The networked nature of these devices allows the communication and information sharing, so that we can share the information within them, while the devices are personal. The users could take these devices, so that these are portable and can be available in many different locations. These are personal portable technologies.

Some other technologies, less portable than mobile phones and PDAs, can still offer personal interactions within learning experiences. The classical educational system, from the second quadrant, consists from devices for individual students used in the educational system. The technology is static because it can be used in only one location, but it is personal because each user

has its own device, account, or profile
In the third quadrant, there are examples of technologies that can provide learning experiences; even the devices themselves are not physically movable. Examples of these kinds of devices are informational kiosks, interactive museum displays, and so on. In these kinds of educational experiences, the user is moving and the delivery technology cannot be moved at all. Multiple users could share these kinds of technology and so that, these are portable technologies.
In the fourth quadrant, we have technologies, as interactive whiteboards and videoconferencing facilities with interactions that are more shareable because the devices are larger and so are less portable.
The mobile technologies comprise all devices from quadrants 1, 2 and 3.

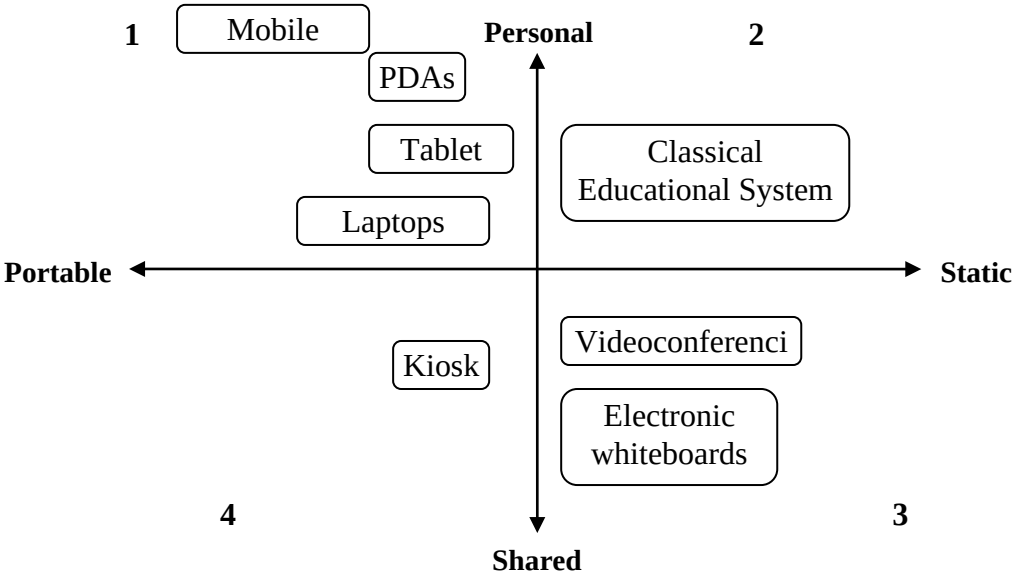

Fig. 1. The Classification of Mobile Technologies

2.2 Multimedia Solutions for M-Learning

M-learning is related to mobile devices by peripheral devices and by communication devices connected to m-technology like: mobile phone, Personal Digital Assistants (PDA), programmable computers, iPod, Personal Video Player and digital video cameras.
The main multimedia solutions for M-learning suppose to use:

- Virtual reality and simulation environment which provide complex solutions for instruction and for exercising the interactions. The virtual reality could simulate a finite space or an open space, inside the nature and allow implementing a variety of interactions.
- Interactive software programs simulate various practical situations and facilitate the educational process.
- Using peripheral devices and multimedia equipments which allow to collect and to interpret, in real time, values from different medium, This allows using informal solutions for instruction like: botanic garden, zoo, rivers and so on.

Mobile software applications provide a better control of environment and are able to compensate the mobile devices disadvantages like: the existence of intermittent communication connections, the limited communication networks bandwidth, the limited storage space and the absence of the diversity for the interaction tools and the possibility to provide improved social experiences comparing with classical learning solutions. [10]
The mobile technologies are beginning to be widespread used in learning and teaching process.
To develop a suitable mobile system for education is necessary to satisfy some

requirements. The most important requirements are:

- To use the contextual information that helps to adapt the multimedia resources to the technical conditions of each user and to the specifically learning level and training requirements.
- To assure the flexibility and the mobility by the ability to link the activity from the educational process and those from the outside of the educational process and provides students with the possibility to run away from the classroom and to hold the activities that don't correspond with school schedule.
- It is necessary to use adequate, improved software tools to record, to retrieve and to organize the mobile learning experiences.

3. Multimedia Data for M-Learning

The development of multimedia applications, from the last years, due to the exponential growth of the Internet had as consequence a great usage of multimedia data in education. As a result, the importance of the researches in multimedia technologies field had been increasing. Because of the features and characteristics of multimedia data, their management and querying techniques are unlike than those of traditional data.

3.1 Multimedia Data Characteristics

The usage of multimedia data as objects is a big challenge in M-learning systems.

Multimedia data is heterogeneous from many points of view:

- some data is time dependent and the other is time independent,
- multimedia data uses different formats for data representation,
- some data is structured and some data is represented as unstructured or as semi-structured streams of data,
- some kinds of data can be transferred remotely in a short time and the others need a large period to be transferred.

We can think about a multimedia system for e-learning like a set of software components that include a collection of multimedia elements: pictures, texts, video and audio sequences and a range of spatial and temporal information used to describe the places of multimedia elements within each component of the system.

If we choose to create multimedia training materials in a manual authoring way, it is necessary to explicitly specified, in the training components, for each multimedia component: text, video, audio and animation, the place and the time in which it must appear. In this situation, it is necessary to modify each time the training components or to build different versions for the same training component, whenever the users' context changes. If it is necessary to modify some elements of multimedia training component, or if we want to deliver the same component on different kinds of platforms, like the Internet environment, on mobile devices with various capabilities, or if the training component is to be adapted to the user preferences, it is necessary to create different versions for the same multimedia training component.

4. Template Based Multimedia Tools Generation

One solution is to build templates and to use them to automatically generate, for each particular situation, new training materials or to automatically recreate the training materials when it is necessary to update or to replace the training content. To do this, it is necessary to build a semantic system that must contain the relationships between multimedia educational elements and the semantic characteristics of each element. We can use this kind of system to build automatically complex systems, adapted to some criteria, but keeping unchanged the educational information.

The multimedia content description supposes to make the abstraction of low-level details of the presentation and to indicate the semantic relations between multimedia elements. Using this information it is possible to generate the educational materials from semantic relations that indicate how could be suggested each semantic relation, using multimedia constructions. We can have

different multimedia educational components automatically generated, function on software or hardware platform used to manage the educational materials, function on users' preferences and function on the type of communication network.
The template based generation of multimedia training materials uses multimedia content description to create the educational materials. We proposed a web based solution that could be used on mobile and non-mobile systems too.
This issue supposes to use some transforming rules and a set of constraints that provide us the final multimedia presentation.
The processing level allows the web browser to know which are the video streams, the audio sequences and the static images displayed to the final user and the timeline for each multimedia element. Therefore, the processing is not at the server level, and is at the client level. We can minimize the negative influence because of the dynamic feature of the communication networks and we can assure a good quality for the final presentation.

4.1 Using MPEG-21 Standard for Multimedia Content Adaptation in M-Learning Systems

MPEG-21 is an ISO/IEC 21000 standard of *Moving Picture Experts Group* (MPEG) that defines an open framework for multimedia. The power of MPEG-21 is demonstrate in the following situation: we can use many multimedia resources to develop an infrastructure for multimedia content delivery and consume. However, it is no architecture used to describe how these elements interact one with the others. The goal of MPEG-21 standard is to define an open framework for multimedia to allow the transparent usage, having good performances in the control of multimedia resources, using various networks and peripheral devices and mobile devices. MPEG-21 offers an open support to deliver and to use the multimedia data [6].
MPEG-21 standardizes the stream of multimedia information and services from the content development until the delivery to the final users. To realize these stages is necessary to identify, to describe, to manage and to protect the multimedia content. The multimedia content transport and delivery could be made throw various networks and between different types of terminals.
Two important concepts define MPEG-21 standard: the definition of a fundamental unit for distribution and transaction, namely the digital element, and the users that interact with digital elements.
The digital element is a digital object with a standard structure that has metadata associated with it. The digital elements contain both multimedia resources, the content, and metadata associated with resources or with the digital element.
In the MPEG-21 standard, a user is any entity that interacts with MPEG-21 environment or that uses a digital element, e.g. a multimedia data consumer, an organization or another standard that use multimedia resources. A user can consume multimedia content in different ways: by publishing or by delivering and can have specific rights and responsibilities, function on the techniques of interactions with the others user in the MPEG-21 standard.
We choose to use MPEG-21 standard for digital elements declaration because this standard offers a generic tool for multimedia content description and for standardization in the educational multimedia components development.
MPEG-21 components used for digital elements description have the following signification:

- The **Item** is the declarative form of the MPEG-21 digital element. An item is composed from a group of sub-items and/or elements with relevant descriptors;
- The **Descriptor** contains information about the items, like the activity;
- The **Component** realizes the link between a resource and all its relevant descriptors and contains information about all parts of one resource;
- The **Resource** is an individual element identifiable by an address and it is use to

identify the video sequences and the static images of one presentation.

4.2 The Technical Solution for Template Based Training Materials Generation

To implement these issues we used a XSLT (eXtensible Stylesheet Transformations) document to transform the MPEG-21 document, based on XML (eXtensible Markup Language), in a HTML (HyperText Markup Language) document, which allows to generate and to adapt the final presentation depending on the available resources or depending on the users' preferences.

We dynamically generate the MPEG-21 document in XML format, at run time, function on user's preferences or function on the technical conditions, using content-based querying. The MPEG-21 document describes the digital elements used inside the multimedia web presentation. We transform MPEG-21 document in an HTML document based on a schema attached to the XML document.

We use a C# solution to build and to implement the system.

To generate and to format the MPEG-21 document, we used *XmlTextWriter* class, in the following way:

```
xw=new XmlTextWriter( Server.MapPath ("Presentation.xml"),
System.Text.Encoding.UTF8);
xw.WriteStartDocument(true);
xw.Formatting=System.Xml.Formatting.Indented;
String PItext = "type='text/xsl' href='prez.xslt'";
       xw.WriteProcessingInstruction("xml-stylesheet", PItext);
       xw.WriteStartElement("DIDL","urn:mpeg:mpeg21:2002/01-DIDL-NS");
       xw.WriteAttributeString("xmlns","xsi",null,"http://www.w3.org/2001/XMLSchema-
instance");
xw.WriteAttributeString("xsi","schemaLocation",null,"urn:mpeg:mpeg21:2002/01-DIDL-
NS mpeg-21.xsd")
xw.WriteStartElement("Item");
       xw.WriteStartElement("Descriptor");
       xw.WriteStartElement("Statement");
       xw.WriteAttributeString("type","urn:mpeg:mpeg21:data-format:IPTCMime-
TypeCS:text/xml");
……..
xw.WriteStartElement("tr");
       xw.WriteAttributeString("height","250");
       xw.WriteAttributeString("width","800");
       xw.WriteAttributeString("valign","top");
       xw.WriteAttributeString("align","center");
       xw.WriteStartElement("td");
       xw.WriteEndElement();
       xw.WriteStartElement("td");
       xw.WriteStartElement("htmltime","seq",null);
       vant=0;
       for (int i=0;i<al.Count-1;i++)
       {
              // add the images in the XML file
       xw.WriteStartElement("link","LINK",null);
       string imag=((Imagini)al[i]).imag;
xw.WriteAttributeString("target","#"+imag.ToString()+"-text");
       xw.WriteStartElement("htmltime","img",null;
       xw.WriteAttributeString("src","mpeg21-replacement");
string inc=vant.ToString();
string dur=Convert.ToString((((Imagini)
al[i+1]).nrframe((Imagini)al[i]).nrframe)/25;
xw.WriteAttributeString("begin","1");
xw.WriteAttributeString("dur",dur.ToString());
       xw.WriteEndElement();
xw.WriteEndElement();
       }
       xw.WriteStartElement("link","LINK",null);
       imag1=((Imagini)al[al.Count-1]).imag;
       xw.WriteAttributeString("target","#"+imag1.ToString()+"-text");
```

```
xw.WriteStartElement("htmltime","img",null;
xw.WriteAttributeString("src","mpeg21-replacement");
       xw.WriteAttributeString("begin","1");
       xw.WriteAttributeString("dur","indefinite");
       xw.WriteEndElement();
       xw.WriteEndElement();
```

The previous code creates a new instance of *XmlTextWriter* class, used to create and to write on the web server a new XML file, *Presentation*.xml. The elements and attributed added correspond to the MPEG-21 file structure presented hereinafter.
We transform the MPEG-21 document in an HTML document based on a schema attached to the XML document.
We defined a container that stores information about the multimedia elements, the time interval in which the presentation will display each multimedia element. We use this container for synchronization the multimedia elements during the presentation
The link between the name of elements and the corresponding multimedia resources is made by digital elements description presented in MPEG-21 format. The MPEG-21 descriptions for images components are presented in the following example:

```
<Component id="images">
<Descriptor>
     <Component id="right">
       <Resource ref="pictures/right.jpg" type="image/jpg" />
     </Component>
 </Descriptor>
 <Descriptor>
     <Component id="front">
       <Resource ref="pictures/front.jpg" type="image/jpg" />
      </Component>
  </Descriptor>
  <Descriptor>
      <Component id="left">
         <Resource ref="pictures/left.jpg" type="image/jpg" />
       </Component>
   </Descriptor>
   <Descriptor>
     <Component id="back">
       <Resource ref="pictures/back.jpg" type="image/jpg" />
      </Component>
    </Descriptor>
……….
</Component>
```

Based on MPEG-21 XML files we generate automatically the HTML files for mobile and non-mobile devices too, using the following set of instructions:

```
XPathDocument xmldoc = new XPathDocument(Server.MapPath("Prezentare.xml"));
XslTransform xslt = new XslTransform();
xslt.Load(Server.MapPath("Transformari.xslt"));
XmlUrlResolver urlResolver = new XmlUrlResolver();
urlResolver.Credentials  = CredentialCache.DefaultCredentials ;
xslt.XmlResolver = urlResolver;
xslt.Transform(Server.MapPath("Prezentare.xml"),
Server.MapPath("Prezentare.html"),urlResolver);
Response.Redirect("Prezentare.html");
```

To automatically detect the hardware characteristics of mobile devices we used the standardized system WURFL (*Wireless Universal Resource File*). We used this information in the system to include/ not include video and image content in the training component when it is requested by a device with/ without technical possibilities

for this kind of multimedia elements [8][9].

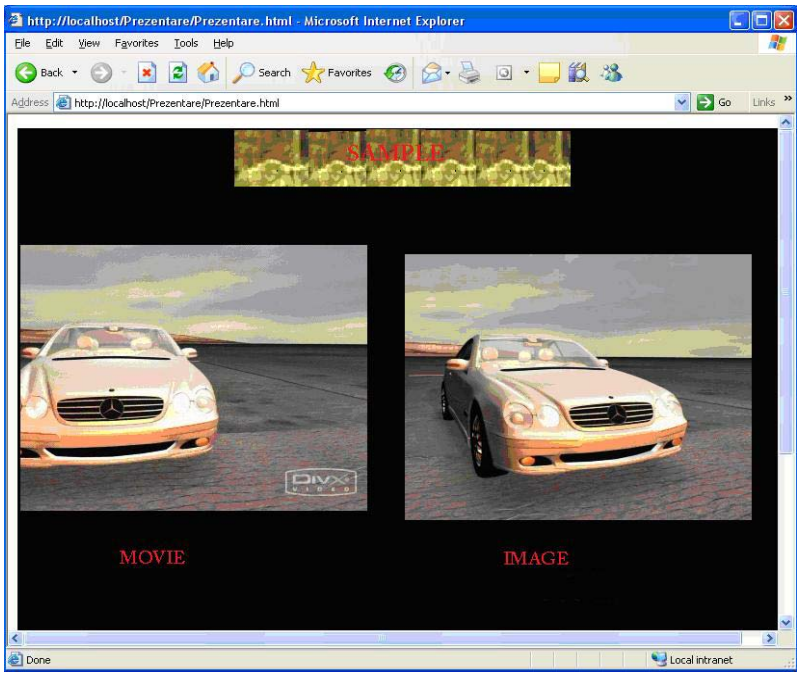

Fig. 2. Sample of a training component generated based on a template

In the figure 2 it is an example of a HTML file containing synchronized text, image and video, generate using the template based solution.

5. Conclusions

The solution proposed in this paper allows: to generate educational materials starting from a set of multimedia resources based on a template that let to adapt them to the specific technical conditions and users preferences, and to change the formats of available educational materials so that to have a unitary presentation for them and to transform them in a format available for mobile devices too.

The open, template based and standardized solutions used to develop the architecture proposed in this paper assure the possibility to generalize the educational multimedia components development.

6. References

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