

Building Geo-referenced Learning Objects with Mobile Multimedia Book

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Abstract: This paper proposes a definition of geo-referenced learning objects. It shows how they can be semantically indexed and stored in specific repositories. Compared to other resources, the use of these objects is not really different, but the way of building them requires some helpful tools because they often have to be created on the field. We first give technical aspects that we advice to follow for running these applications. Then we present and illustrate an application that can be installed on mobile devices, which simplifies the gathering of constituent elements of geo-referenced learning objects.

Key-Words: Learning Object, Location, Mobile Device, Multimedia, Ontology

1 Introduction

Professors, researchers and students of different disciplines like biology, geology, botanic, archeology, etc., have to move on places to concretely study their subjects. They need to verify, go deeper and reinforce knowledge that they acquire with more traditional approaches. Several experiences have demonstrated the usefulness of such approaches (see [14]).

During the on-the-field visits, learners can write notes, take photos, register observations and consult previous information about locations they are observing. The current technology now gives people an easy way for performing all these actions with mobile devices.

Videos, photos, notes and audio records represent an important source of knowledge if linked together and referenced to the location where they are taken. Each of them may enter in the composition of a geo-referenced learning object (GRLO) bringing different points of view or completing notions about a location.

Generally speaking, research papers insist on technological features or limitation of devices, like capacity, difficulties to access the net, etc. The objective of this paper is to give considerations about the structure and the building of these new kind of learning objects that mobile devices allow to build even if some limitations exist.

Section 2 gives the definition of geo-referenced learning objects, some elements of ontology allowing them to be semantically indexed and thus to be discovered in repositories of resources. Section 3 presents the technological characteristics that we consider important for really building these objects on the field.

Section 4 describes the application we are developing and which is useful for easily putting together the

components of GRLO. This tool is designed to be general enough for being installed on several mobile devices. Section 5 presents some related projects.

2 Geo-Referenced Learning Objects

Geo-referenced learning objects are objects associated with a specific location. When indexing them, meta-data or semantic description contains the location information associated with. These objects are generally used in learning environments running on mobile devices having a system providing the position of the user automatically.

2.1 Location

To define a location, it exists several ways. The main one is using a geographic coordinate system, i.e. latitude-longitude, whose values are collected by a GPS device. For example, a point on the earth can be defined by (East, 38° 59' 3,80''; North, 09° 00' 59,72''). For convenience, it is possible to transform latitude and longitude into UTM [2] coordinates expressed in meters from an origin, using a specific algorithm.

The second one is a more classical way of defining a place specification: address, with country, city, street and numbers. The location may also be a site or an area identified by its name, the region and the country where it is situated. For example, an archeological site is well known thanks to its name but it is also possible to specify a place inside a site. The location is then a couple containing a place name and a site (ex: the theater of the archeological site of Nora in Sardinia, Italy).

It is often necessary to consider uncertainty around a location. The nature of this uncertainty depends on the

representation system of the location. Considering the GPS-taken position, defined by a couple of angles representing latitude and longitude, uncertainty is given by some seconds of angle.

2.2 Indexing

Indexing geo-referenced learning objects requires a specific ontology for representing the concepts attached to locations. We can define the `Location` concept and some subclasses:

```
(GPSLocation subclassOf Location)
(AddressLocation subclassOf Location)
(SiteLocation subclassOf Location)
(ReferenceLocation subclassOf Location)
```

Then we assign a `Location` to a learning object by the following `hasLocation` relation:

```
(hasLocation domain LearningObject)
(hasLocation range Location)
```

A `GPSLocation` must be considered as the domain of two relations: `hasLatitude` and `hasLongitude` whose range is a `DirectedAngle`. A `DirectedAngle` is associated with a direction and an angle. An `AddressLocation` is associated with several usual concepts like `Street`, `Region`, `Country`, etc. A `SiteLocation` has a name and is associated with a particular address (region and country). A place in a site has a name and is associated with a site. A `ReferenceLocation` is concerning locations given by a building or a monument (for example the Eiffel Tower in Paris).

A GRLO may be associated with more than one location. Sometimes, it is necessary to know both the `GPSLocation` and the `SiteLocation` of a place. Some learning scenarios are based on double location.

2.3 Discovery

The discovery of geo-referenced learning objects is based on semantic information. It depends on the subclasses actually represented in ontology. In knowledge bases containing both ontology and axioms about individuals, agents can search for results from specific requests. An example of technology dealing with such bases is given by the Jena framework [3]. Requests are expressed using the RDQL language [4] but SparQL [5] requests are also accepted. As each location can be diversely represented, queries must be adapted to each location category.

If location is concerning a `GPS Location`, some uncertainty must be given when searching for an object.

In some cases, search engines calculate using a default uncertainty.

For other location representation, it could be interesting to search for objects linked to the same area or city. The concept of proximity between locations which is obvious with `GPS Location` can be extended to other types of location. For example, referenced locations can be considered near in space if they are situated in the same city. Two places inside the same site can also be considered close.

More and more mobile devices are embedding systems giving their `GPS Location`. It is interesting in actual learning scenarios, to exploit this information and propose some documents or some verifications according to the given location value.

3 Devices and Wireless Communication

Mobile customers need and desire to be continuous connected to Internet, exchange data with any type of digital device whose processing capabilities let them work with only one hand.

Nowadays, it is possible to consider a lot of similar devices, classified according different categories. Ranging them from the simplest ones to the most sophisticated ones, we can cite smart-phones, internet tablets, pocket PCs, PDAs, ultra-mobile PCs and go-anywhere computers or tablet PCs. The hardware and connectivity capabilities of previous mobile devices are very close and their features almost contiguous.

The evolution of material is very fast and distinction between two types of devices becomes difficult. For example if the first model of a product must be considered as a smart-phone, the following release will also be considered as a smart-phone although it has almost the same performances as a PDA.

In our project, to build the so called geo-referenced learning objects, we would need a device with audio recorder, photo camera, GPS and notepad. It must also be able to connect to Internet, to load and process Java applications. However, among the devices of the six previously listed categories, none has all required features but all of them have built-in Bluetooth feature [6] for inter-device connectivity. Thus, each of them can communicate with Bluetooth-enabled GPS, photo camera or other accessory and collect all type of pieces of information required to compose a complete GRLO.

In these conditions, we have to consider a configuration of a set of accessories around a main central unit, to fulfill our objectives. Each complementary accessory provides for a specific element, like a `GPS location` or an image, to the central unit having the power of processing the data. The main unit is able to establish wireless Internet connections through the GPRS or UMTS mobile network - their

maximum speed is, respectively, 64 Kbps [7] and 384 Kbps [8].

For our purpose, we can identify two ideal configurations. The set of accessories is the same: a GPS card to gather position and a Bluetooth-enabled photo camera or smart-phone to take photos. The difference is in the processing unit: a PDA with the GPRS/UMTS card or a go-anywhere computer for collecting data, register audio spot and write notes. Fig. 1 presents the two types of communication: using Bluetooth (left part of the figure) and Internet connection (towards the WWW symbol).

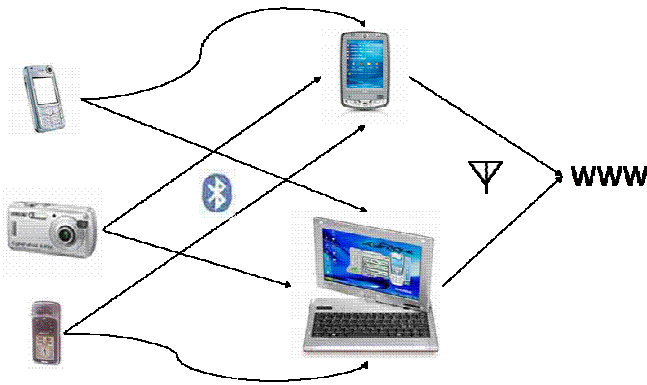


Fig. 1. Wireless communication schema between devices and Internet.

4 Building Geo-Referenced Learning Objects

The available technology provides all elements we need to assemble GRLOs. However, it is absolutely necessary to have an application for easily linking together these components and transfer data to the central unit. In the following sections, we describe a tool use to build simple or complex learning objects. This application is realized by associating multimedia elements and GPS locations.

4.1 From Paper Book to Multimedia Book

When groups of people, like students, professors and researchers, of different disciplines (such as archeology, biology, geology or botanic) move on places they want to study or observe, they generally take notes on paper book.

We propose to transform paper notes into digital notes and add multimedia elements. During the visits, they can store information about observations, write notes but also take photos, and register sounds or audio files. It is

thus necessary to manipulate a photo camera and an audio recorder.

To simplify the so called multimedia annotation of a place, we propose a multimedia book, i.e. an application allowing the gathering and the processing of all multimedia data. In device having an Internet connection, the application could send data in real-time to remote server.

Like a paper book, the multimedia book is made of sheets. In each sheet it is possible: to write notes; to link registered sounds or audio comments; to include photos taken with the digital photo camera and transferred to the main unit by a Bluetooth connection; to create links with encyclopaedic data items preloaded on the device by the student or professor.

Fig. 2 shows an example of a sheet of the multimedia book.

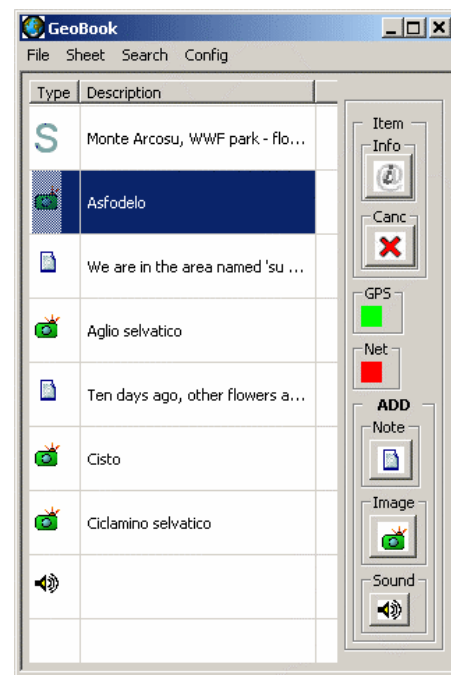


Fig. 2. A sheet on the book.

4.2 The objects

For each taken data, when a GPS device is available, the multimedia book automatically joins a set of meta-data that can be modified partially by the user.

Each note, sound and image is linked with the position where it was taken, while each sheet is bound to a geographic area centred on the coordinate values given at the moment of its creation and having a radius specified by the user. The sheet represents a complex GRLO composed by a collection of notes, audios files

and images. Only simple objects having a relation with the area referenced by the sheet can be added to it.

All GRLO have the time-stamp of their creation. The notes are also associated with the time of their last change. A text analysis provide for a set of keywords, allowing the object to be indexed on a knowledge domain. The keyword set is only proposed and is modifiable by the user while creation and update time are not.

Fig. 3 and Fig. 4 show an image selected on a sheet and its properties.

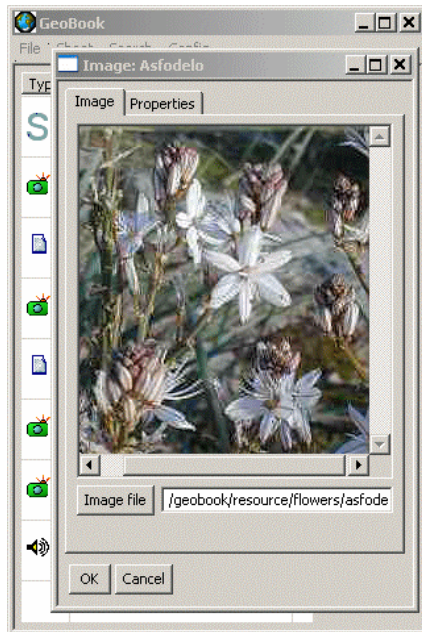


Fig. 3. An image selected on a sheet.

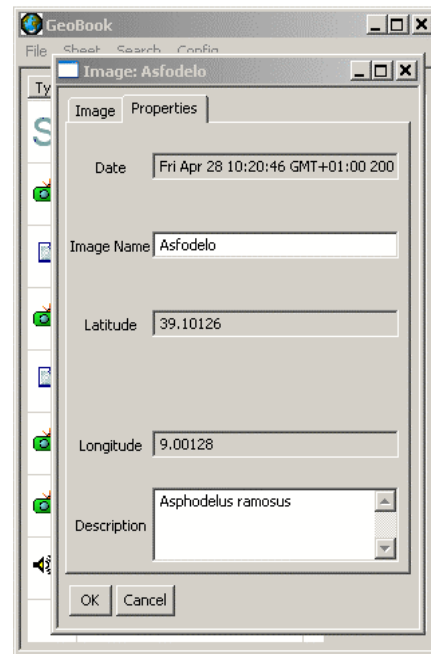


Fig. 4. The previous image properties.

4.3 Sheet selection

To provide for a fast and simple access to the stored sheets, the book gives some filtering possibilities:

- by date, specifying the starting and final days,
- by position, using the current GPS position, a manually entered position or a name,
- and by keywords.

The selected sheets are listed by the chronological order of their creation date. The user can also list all local stored sheets (Fig 5).

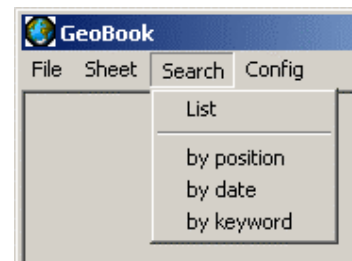


Fig. 5. Select and search sheets.

4.4 Storing the learning objects

The book allows to store locally or remotely the learning objects. To store locally, we choose the Apache Derby [9] DBMS. Thanks to its lightweight and its possibility to be embedded, it is suitable to be used with PDA applications. Through GPRS/UMTS connection, the data can be transferred to a remote registration server.

A server has not only the responsibility to store data without modifying their format but they have also process them. Each server may expose a set of additional actions during the storing of the received data. It can be asked to perform one of these tasks. Such actions require power, hardware resource and Internet connection not available on mobile devices. Some examples are:

- animal, flower or insect recognition on images;
- sound analysis;
- information comparison with large external database;
- process based on geographical areas.

A copy of data included in the sheet selected on the mobile device is sent to the server. In case of areas without GPRS/UMTS coverage or if connection problems occur the copies are not sent in real time to the server but are maintained locally. In this case, the copy synchronization with the server is managed by the user with the support of the application. The user may decides two actions: either download data from server and update local copy or send local data to server and update remote copy. The application shows an alert message when a recent data is going to be overwritten by an older one.

5 Related Works

Numerous projects, researches and studies are focusing on the use of mobile devices in e-learning applications. Sometimes, they support used students inside the classroom itself ([10], [11] and [12]).

Promising experiments are concerning the support of mobile devices for learning purposes outside schools. It is possible to exploit these tools almost anywhere and at anytime according to the characteristics they provide. [13] and [14], show on-the-field lessons tailored on a specific study. In [15] and [16], the PDA becomes the device for learning a language supporting the user to prepare an exam or to learn words and sentences. Other works have exposed how multimedia can improve student learning (i.e. [17] and [18]).

Regarding learning objects, numerous papers describe platform for developing, storing and using learning objects (i.e. [19], [20] and [21]). Some others, such as [22], [23] and [24], define extensions of the IEEE Learning Object [25] model.

6 Conclusion

In this paper, we have proposed the structure of geo-referenced learning objects (GRLO) and described the geo-referenced and multimedia book, an application allowing to build such objects.

The combination of composing learning objects on mobile devices and the inclusion of location information represents an interesting and innovative research line. The application described in this paper realizes this composition. Furthermore, it supports studies and investigation on subjects requiring on-the-field visits to be better understood. The multimedia book favors the collection of data from different sources and their transformation in real learning objects.

They are enriched with metadata and the position of the location where they are collected. The position is an important data item that lets to identify the environment, either natural, archaeological, industrial or civic, and to filter the related information. The objects are grouped by position in sheets to realize complex learning objects. Thanks to Internet connection, the built GRLOs can be sent in real-time to remote server for data processing requiring resources not available on the mobile devices and for be shared with experts and collaborators.

Besides the building of geo-referenced learning objects, we can imagine further use of the multimedia book. Studies requiring a periodic monitoring of selected areas for the observation of the climate or the pollution effects on vegetation, water and ground could use efficiently our application.

References:

- [1] Rogovin A., *Learning by doing: home and school activities for all children*, Nashville - USA, Abingdon Press, 1998
- [2] John Carnes, Using the UTM map coordinate system, <http://www.maptools.com/UsingUTM/index.html>
- [3] Jena Semantic Web Framework, <http://jena.sourceforge.net/>
- [4] RDQL - A Query Language for RDF, <http://www.w3.org/Submission/RDQL/>
- [5] SPARQL Query Language for RDF, <http://www.w3.org/TR/rdf-sparql-query/>
- [6] Bluetooth, <http://www.bluetooth.org>
- [7] GPRS Class Types, <http://www.gsmworld.com/technology/gprs/class.shtml>
- [8] What is UMTS?, http://www.umts-forum.org/servlet/dycon/ztumts/umts/Live/en/umts/What+is+UMTS_index
- [9] Apache Derby, <http://db.apache.org/derby/>
- [10] Dawabi P., Wessner M. and Neuhold E., Using mobile devices in the classroom of the future, in *Mlearn 2003*, London – United Kingdom, 2003, pp. 55-60
- [11] Zurita G., Nussbaum M. and Sharples M., Encouraging face-to-face collaborative learning

- through the use of handheld computers in the classroom, in *Mobile HCI*, Udine – Italy, 2003.
- [12] Mercier F., David B., Chalon R. And Berthet J.P., Interactivity in a large class using wireless devices, in *Mlearn 2004*, Bracciano (Roma) – Italy, 2004, pp. 129-132.
- [13] Giroux, S., Moulin, C., Pintus, A. and Sanna, R., Mobile lessons: Lessons Based on Geo-Referenced Information, in *E-Learn 2002 Conference*, Montreal – Canada, 2002, pp. 331-338.
- [14] Pintus A., Carboni D., Paddeu G., Piras A. and Sanna S., Mobile Lessons: concept and applications for ‘on-site’ geo-referenced lessons, in *Mlearn 2004*, Bracciano (Roma) – Italy, 2004, pp. 163-165.
- [15] Trifanova A. and Ronchetti M., Prepare for a bilingualism exam with a PDA in your hands, in *International Conference on Methods and Technologies for Learning 2005*, Palermo – Italy, 2005, pp. 343-348
- [16] Kadyte V., Learning can happen anywhere: a mobile system for language learning, in *Mlearn 2003*, London – United Kingdom, 2003, pp. 73-78
- [17] Khaund M., Enhancing student learning: a multimedia case study, in *International Conference on Methods and Technologies for Learning 2005*, Palermo – Italy, 2005, pp. 113-120
- [18] Ottaviano S., Chifari A., Fiandaca M. and Gentile M., A multimedial environment to train mathematical problem solving, in *International Conference on Methods and Technologies for Learning 2005*, Palermo – Italy, 2005, pp. 557-560
- [19] Ford L., A learning object generator for programming, in *9th Annual SIGCSE Conference on innovation and Technology in Computer Science Education*, Leeds – United Kingdom, 2004, p.268
- [20] Abernethy K., Treu K., Piegari G., and Reichgelt H., A learning object repository in support of introductory IT courses, in *6th Conference on information Technology Education*, Newark – USA, 2005, pp. 223-227
- [21] Yang D. and Yang Q., Customizable distance learning: criteria for developing learning objects and learning model templates, in *7th international Conference on Electronic Commerce*, Xi'an – China, 2005, pp. 765-770
- [22] El Saddik A., Ghavam A., Fischer S., and Steinmetz R., Metadata for smart multimedia learning objects, in *Australasian Conference on Computing Education*, Melbourne – Australia, 2000, pp. 87-94
- [23] Li L., Shi H., Shang Y., and Chen S., Open learning objects for data structure course. *Journal of Computing Sciences in Colleges*, Volume 18, Issue 4, April 2003, pp. 56-64.
- [24] Skår L. A., Heiberg T., and Kongsli V., Reuse learning objects through LOM and XML, in *18th Annual ACM SIGPLAN Conference on Object-Oriented Programming, Systems, Languages, and Applications*, Anaheim – USA, 2003, pp.78-79
- [25] IEEE Learning Technology Standards Committee (LTSC) IEEE P1484.12 Learning Objects Metadata Working Group, <http://www.ieeeltsc.org/wg12LOM/>